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San Diego, Important Naval and Military Center, Whose Port Facilities Are Described in This Issue
For Final Program of Society's Convention, to Be Held in San Diego July 23–25, 1941, See Page 421

Volume 11 Number 7

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

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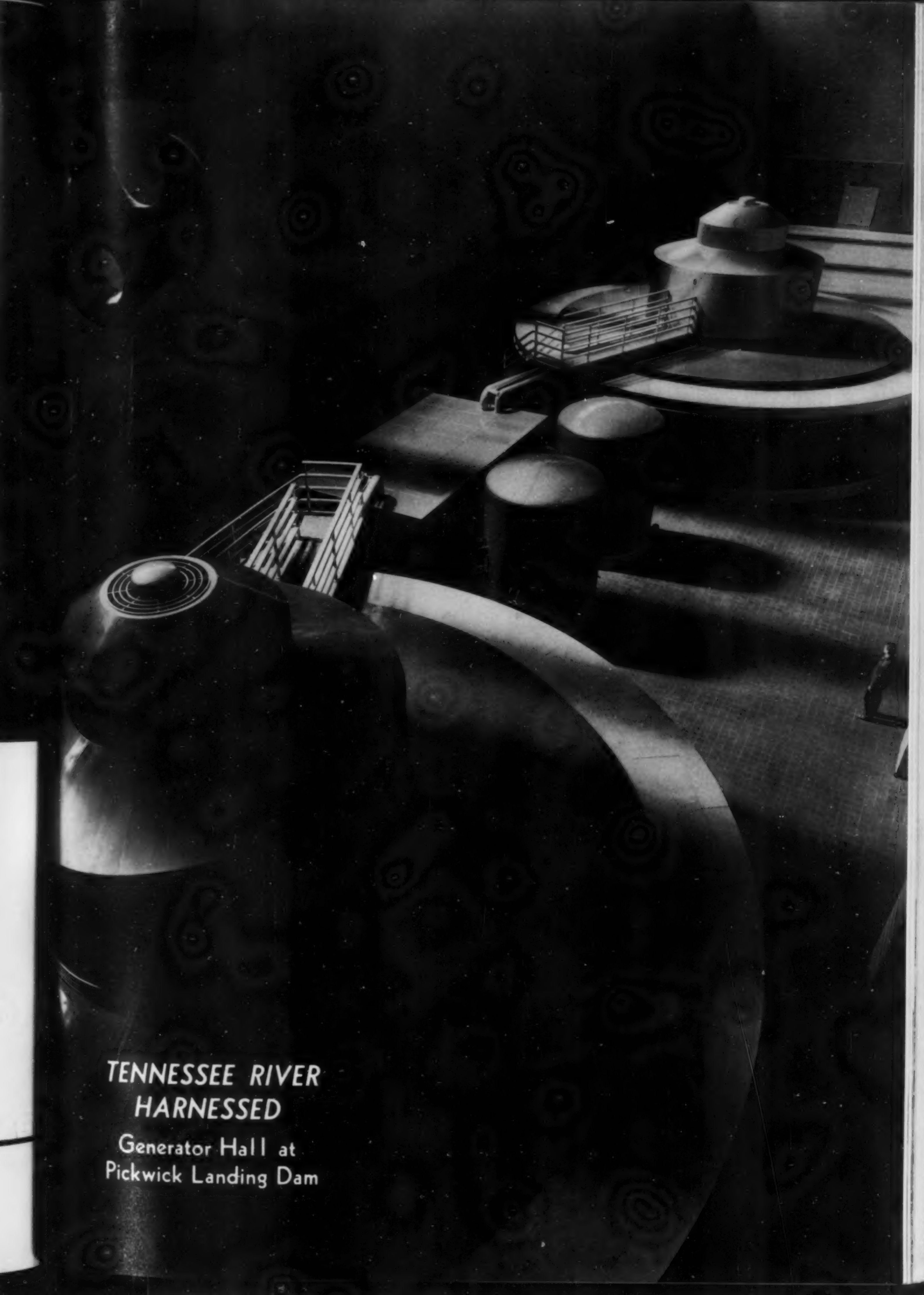

TENNESSEE RIVER HARNESSED

Generator Hall at Pickwick Landing Dam

Among Our Writers

H. B. Cooley (Tulane U., B.E., '21, LL.B., '28, C.E., '31; Harvard U., M.B.A., '37) has practiced engineering, primarily in the field of construction, for 15 years and is a member of the Louisiana and West Virginia bars. For 4 years he has taught economics and business administration at West Virginia U.

Paul E. Tignor (Johns Hopkins U., B.E., '20) has been connected with the Glenn L. Martin Company for the past 12 years as building and field engineer and airport manager. Prior to that he was in general construction work. He is a Lieutenant Commander C.E.C. Bureau of Yards and Docks, U.S.N.R.

Richard Shelton Kirby (Sheffield Scientific Sch., Ph.B., '96; C.E., '98) has been in charge of the teaching of engineering drawing and specification writing at Yale since 1915. His earlier work was in general engineering practice at Port Chester followed by teaching at Yale and Gettysburg College. He is the author of several books on drawing and co-author of *The Early Years of Modern Civil Engineering*.

Carroll A. Towne is chief of the Recreation and Public Grounds Division, Department of Regional Studies, TVA. He is responsible for the design of all employee housing and related structures required by TVA, including planning and development of recreation areas on lakefront properties. Mr. Towne went to the TVA in 1933 as a landscape architect, a subject in which he majored and which he later taught at Massachusetts State College.

Robert H. Burrage (Harvard U., A.B., '13; M.E., '16) served on the Mexican Border and with the First Army in France, and was an instructor at the Army Engineer School. As a lieutenant with the 27th Engineers in the A.E.F., he participated in extensive bridging operations. Normally an engineer with the Public Roads Administration, he has been active in the Reserve Corps and is now a Major on duty in the Office of the Chief of Engineers.

J. W. Moreland (U. S. Military Academy, B.S., '20; R.P.I., C.E., '22) has spent 20 years in Army work, first as instructor in military engineering at Virginia Military Inst., later as instructor of mathematics at U.S.M.A. In addition he has had charge of road and bridge construction, swamp reclamation, and dredging in Puerto Rico. Major Moreland is now U.S. District Engineer, Corps of Engineers, St. Paul, Minn.

Ralph Lowry (State College of Wash., B.S., '13; M. in C.E., '17) has been with the Bureau of Reclamation since 1914. Assignments have included Yakima Project, McKay Dam in Oregon, Gibson Dam in Montana, and Lake Cle Elum Dam in Washington. On Boulder Dam, he was field engineer, 1930–1934, and construction engineer and director of power, 1935–1938. Since 1938 he has been construction engineer on Shasta Dam.

George E. Solnar, Jr. (Stanford U., A.B., '36; C.E., '38) has been stress analysist, structural designer, and is now project engineer for the Pacific Railway Equipment Co. of Los Angeles. His earlier experience was along general engineering lines with the cities of Palo Alto and Fresno, Calif.

Russell G. Hornberger (Case School, B.S. in E.E.) has had 4 years with the Bur. of Reclamation, 4 years on industrial electrical systems, and 3 years with a consulting sanitary engineer on electrical and mechanical equipment for water supply and sewage treatment plants. Since 1934 he has been with the U.S. Indian Service on power and pumping plants.

R. H. Van Deman (Harvard U., A.B., '88; Miam Medical College, M.D., '93) is also a graduate of the U.S. Infantry and Cavalry School and of the Army War College. He was appointed Second Lieutenant in the U.S. Army in 1891. During the World War he served as Chief of the Army Intelligence Service, and in 1929 he retired with the rank of Major General. General Van Deman has served as a member of the San Diego Harbor Commission since 1931 and as a director of the San Diego Chamber of Commerce.

K. B. Woods (Ohio State U., B.C.E., '32; C.E., '37) has been instructor in civil engineering at Ohio State University and assistant professor of highway engineering at Purdue. He also spent 6 years as assistant engineer in the Bureau of Tests, Ohio Dept. of Highways, in charge of the soils laboratory and, since 1939, he has been assistant director of the Joint Highway Research Project at Purdue.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Economic Balance and the Engineer

By H. B. Cooley, Assoc. M. Am. Soc. C.E.

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The engineer's training, his whole process of thinking, is primarily that of determining the proper balance between various conflicting forces. Analysis of stresses in a building or a truss; design of a container to resist internal pressure, such as a water tank or pipe for the transporation of liquids and gases; use of compressed air in subaqueous work; erection of a large bridge; and innumerable other instances, illustrate the process by which the engineer plays forces one against another. He thus contrives to maintain an equilibrium—to obtain a balance.

Applying the Engineer's Method.~In other fields, however, a balance between conflicting forces is just as essential as in the field of civil engineering—indeed perhaps more so. They are fields covered by other professions although the engineer is vitally interested in many parts of them—both as an engineer and as a citizen. They are fields in which the engineer's process of analytical thinking, if coupled with some factual knowledge, will go far in remedying the defects in our present economic structure.

There are those who advocate that the engineer should take charge of all social functions. Because he is a good administrator, they argue, he would be able to solve our social and economic ills. To subscribe to any such doctrine would be, in the writer's opinion, a mistake. He does feel, however, that the engineer, through his training, is admirably qualified to undertake the study of many of today's economic problems and to attempt to establish the balance that is so badly needed in various parts of our economic machinery. But in order to do this he must acquire a knowledge of the facts, so far as they may be determined, surrounding the field to be studied.

Engineering Judgment in Other Fields.~As a general rule he forms his opinion on social and economic questions on the basis of insufficient information and jumps to conclusions that he would be unable to sustain if called upon to defend against attack. This is a process which he would not think of using in connection with the design of an engineering project. He is swayed by political prejudices or financial concerns and is unable to view the problem as one of conflicting forces to be studied and brought into balance.

Many of our economic and social problems are so closely related to the work of the engineer that he can no longer afford to ignore them. Certain questions of government employment and regulation, labor legislation, and taxation so vitally concern the engineer that he must analyze them or else he must yield to others his present commanding position as the deciding voice. It is to matters of an even more fundamental nature, however, rather than to such specific applications that the engineer, as a professional man with certain specialized training, must devote his attention. The collection and compilation of facts in many of these fields are the work of specialists, such as the statistician and the economist; but the conclusions to be drawn from these figures, and the remedial steps to be taken, may well call for the judgment and balance of the engineer—a judgment and balance, it is true, that are also possessed by members of other professions.

For example, facts and figures are collected showing the conflict between the various transportation facilities of the country—the water carrier, the railroad, the highway carrier, and the airplane. In what way, if at all, may balance be maintained between these agencies so as to protect the best interests of the general public and of the carriers themselves, both in the immediate present and from a long-run point of view?

Problems of Wealth.~It is generally recognized that there is an uneven distribution of wealth among the different classes in America. What steps may, and should be, taken to establish a balance between the incomes received by rural and urban workers? Can anything be done to build up increased purchasing power in the Southern states among the great percentage of negro population without at the same time injuring the status of the northern industrial workers, or without creating serious social problems in the South, which would simply throw a new strain upon its economy while possibly relieving an old one? What will be the result of mechanization in the cotton fields through the use of the cotton picker? Will it hasten or retard the development of the South industrially—possibly at the expense of other sections? What will be the effect upon transportation in the

North and East, as well as in the South, if there is a rapid industrial growth in the South?

What steps should be considered and taken in preparation for that period after the war when the nations of the world must return to peace-time pursuits? What steps should be taken to restore the balance between the nations that "have" and those that "have not"? Or should we admit that such steps are impossible and that we have truly a society in which might is right, and the strong may prey with impunity on the weak?

Governmental and Industrial Unbalance.~What should be done to restore a balance or establish it if it has not existed in the past, between the scopes of federal and local governments? Is there a proper field within which each can perform its functions to best advantage, or are these functions so intermingled that it is impossible to separate them? In the present chaotic condition must this confusion continue, with the resulting duplication of effort and waste? What, if anything, can be done to establish a balance in the matter of taxation so that it will be fair to the taxpayer and to the collecting agency—a balance that will assure to the taxpayer real benefits in return for the money collected?

Is it possible to establish a balance between the various conflicting interests that arise because of natural conditions and social development? If one state is to erect tariff walls in the form of special taxes against the products of another state, or if truck carriers from one state are to be discriminated against within the boundaries of another state, we are approaching, in this country, the same situation which has caused much of the trouble in the international situation. But is it possible to approach this question in such a way that the various interests concerned will be dealt with fairly and without injury to those who, through their initiative, thrift, and skill, have built up existing enterprises? At the same time is it desirable to protect the existing business? Is it desirable to freeze the economy so as to prevent further advancement? No one would wish to defend today the idea that the wagon and carriage business should have been protected about forty years ago against the encroachment of the automobile industry. Can, or should, these balances be established, or restored in cases where they have existed in the past and have been disturbed in our rapidly moving civilization?

Remedial Efforts Desired.~All these are questions which the engineering profession may well ponder but they should be considered in the light of the engineer's training and not from a partisan political, social, or economic viewpoint. Can, and will, the engineer broaden his vision so that he can examine the complex situations arising in our social and economic life, weighing all the factors it is possible to obtain, in the same manner that he would conduct the investigation and the design of a major structure? Just as the engineer's structures sometimes come short of achieving the purpose for which they were designed, or fail to survive through physical defects, so his attempt to restore balance, or to establish a balance in the economic and social worlds, may meet with failure. Even so, increased effort and thought by the profession toward these objectives would be desirable.

The engineer should devote some professional thought to the fundamental causes of our ills and possible remedies for them. He can no longer hold to himself and say that these problems are only for the economist, the lawyer, the politician, or the accountant. They are vital questions which affect his employment, his business, his functions as an engineer in society. Only to the extent that he is cognizant of the difficulties involved and the possible solutions, can he determine a line of conduct to guide his actions and those of his employer.

Conflicting Pressures.~Many of these problems are being investigated today, and solutions for them are being sought by various agencies throughout the country. In general, however, the solutions are sought by special groups—pressure groups which seek to remedy the evils in such a way as to benefit themselves, and they are opposed by other groups who at the present time have some economic advantage over them. A few illustrations have been mentioned and many others will readily come to mind. In many cases solutions to problems are proposed, enacted into law, and forced upon the majority of society for the benefit of a small group with political influence. The reaction of such an adjustment upon the economic machine is in many cases similar to the disaster that would result if an engineer should adjust a design in some one detail, without regard to the effect upon other parts of the structure. Such action by the engineer, and his disregard of the probable effects of his change in design or construction, might well lead to the collapse of the entire structure or the failure of the machine to operate.

Opposition to Change.~Such shifts in the economic and social machine without regard to the consequences on other parts of it, may well lead to a collapse or non-functioning of the economic and social structure as a whole. On the other hand, history has shown many instances in which certain changes were opposed by the so-called "vested interests" but which were finally forced into being and resulted in certain achievements beneficial not alone to society but even to the very organizations which, in their blindness, had previously opposed the changes. In many other cases the proposed changes have been opposed, not alone by the "vested interest" so called, but by many other clear thinking individuals. When, in spite of this opposition, the adoption of these measures has been forced by pressure groups, experience in some of these cases has proved that the experiments were impractical and unsuccessful and that actual harm resulted to the very group that was to have been benefited by the changes.

A Broader Outlook.~It is impossible for the engineer to keep posted on all events—political, economic, social, and legal—and at the same time to maintain his connection with his profession and keep up with its technical development. It is well, however, for him to learn as much as he can concerning these other fields and apply such knowledge to his engineering work. In many of his investigations the probable effects of a proposed course of action may show conflicting results—one as it concerns society as a whole, or a particular segment of it, and the other as regards his employer or client. In such an event it can only be said that the engineer must make his own decision; but it is submitted that he can make this decision far more wisely if he knows all the various paths that lie before him, than if he decides blindly, purely from the standpoint of his own individual interest.

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Problems in Aircraft Plant Expansion

Difficulties in Design and Erection Solved in Record Time at Martin's Baltimore Factory

By Paul E. Tignor

Building and Field Engineer, The Glenn L. Martin Company, Baltimore, Md.

As a complicated and precise mechanism the modern airplane is outstanding. Similarly the plant for its manufacture involves untold details. But necessity scoffs even at time handicaps, as Mr. Tignor explains. The French Government wanted bombers from a plant which at the time was not even on paper. Within six months plans, contracts, construction, and machinery for a two-story building with 440,000 sq ft of floor area were completed—and its first plane was in the air! This feat and other interesting details of the plant were described in the more inclusive paper given before the Structural Division at the Society's Baltimore Meeting.

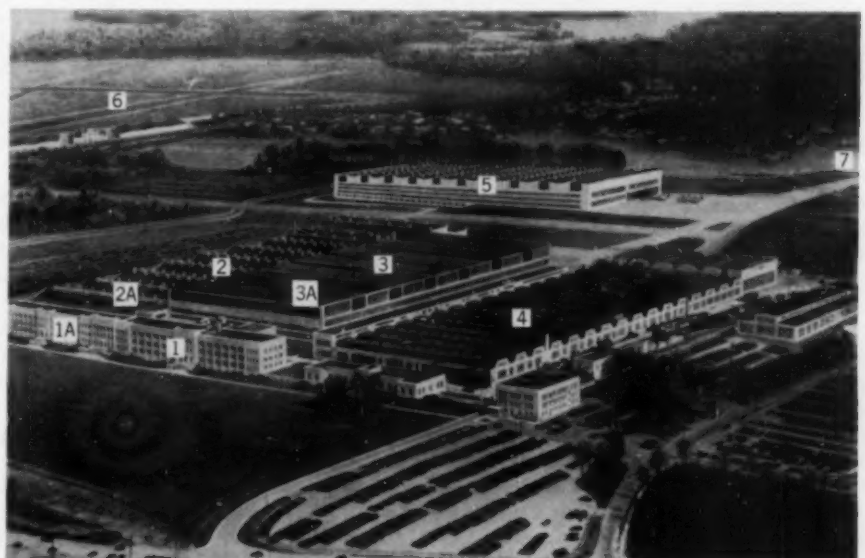
In keeping with the ever-increasing demand for speed, expansion of aircraft manufacturing facilities has become a mild sort of warfare in an attack on time. No longer is it possible to be reconciled to the limitations of time as formerly accepted in the accomplishment of plant construction. New records must be made—made to be broken once again when the next project is conceived. The consummation of aircraft contracts is no longer predicated upon the availability of manufacturing areas. The contract is executed regardless of existing facilities. Delivery of planes is guaranteed on the premise that manufacturing space will be made available for the completion of contract commitments. The die is cast by the governing powers of aircraft production—and the engineer responds by taxing, to the utmost degree of human ability, the resources of mind, men, and material in achieving what was once considered an impossible task.

Designing and erecting any structure suitable for use in the production of heavier-than-air craft present problems peculiar to the intrinsic requirements of this rapidly developing industry. From the basic items of steel, concrete, and glass must be evolved modern daylight structures capable of housing the various operations contributing to the end product—the airplane.

One of the outstanding aircraft plant developments in the United States lies just to the east of Baltimore—the Glenn L. Martin Company. Two separate plants are but little over a mile apart. When completed late in the summer of 1941, they will total nearly 4,000,000 sq ft of floor space.

Such expansion evolves from the Martin Company's remarkable achievement of 1939, when a world record of building construction was achieved by a system of closely coordinating and scheduling the work of 34 subcontracting agencies. But the orderly nature of our entire development stems from one outstanding fact—every single unit of the plant (even the enormous buildings being erected under the national defense program) was provided for in the Master Plan of 1928. It was then that the company made the momentous decision to move its manufacturing plant from Cleveland to Baltimore.

Manufacturing facilities originally provided in the Maryland plant proved to be adequate for almost a decade. Then Mr. Martin foresaw additional demands upon the company. He believed the forthcoming development of larger types of aircraft would result in the



General Layout of Expanded Plant No. 1

Numbered for Identification: (1) Engineering Building with (1A) Extension; (2) "C" or French Building, Completed in 77 Days, with (2A) Extension; (3) "B" or Navy Building, Largest Aircraft Assembly Floor in America, with (3A) Extension; (4) "A" Building, Original Plant Built in 1929, Now Used for Shops Only; (5) "D" or New Navy Building, to Be More Than Twice as Large as "B" Building; (6) Private Airport with Hangars; (7) Access to Middle River (Leading to Chesapeake Bay) for Launching and Testing Flying Boats

◄ Plant No. 1 After Several Stages of Expansion
Extension of Engineering Building Under Construction, with Enlargements of "C" (French) Left, and "B" (Navy) Center, Already Completed

In March 1939, from the Air
Left, "C" Building Under Construction, Less Than Six Weeks After Ground Was Broken; Center, "B" Building, with Engineering Building in Front; Right, "A" Building, with Administration Building in Front

evolution of an entirely different sort of manufacturing unit. Events have vindicated this judgment.

Incorporated in this new development was the utilization of what is still considered a radical experiment in plant design. In acquiring a single span of 303 ft $7^1/_2$ in. with a clear height of 43 ft 6 in. under the bottom chord of the truss, we feel that we have made at least a small contribution to the development of aircraft plant construction. Admittedly, ours is the largest single-unit aircraft assembly floor in the United States—and the accomplishment of providing such an unusual structure in keeping with the demands of progress is a source of real pride.

The Navy assembly building, our Building "B," contains several valuable developments. Roof trusses are built up of latticed members and span the full 300-ft width. Monitors run parallel to and encase the trusses, thus diminishing the total height of the building without decreasing interior headroom. Heat loss through extensive glass areas and openings is counteracted by hot-air outlets in the perimeter of the floor with return inlets down the center.

One unique feature is the hangar doors. A specially designed telescopic canopy type was used, lifting in three sections in 68 seconds to provide an unobstructed opening 300 ft wide and 40 ft high. While a saving in initial cost of approximately $15,000 would have resulted from installing slide-type doors, their operation would have cost the equivalent of one ton of coal for each opening. Consideration of maintenance costs, space and heat saving, weather-stripping, door operation, controls, support, and other conveniences led to the development of the telescopic cantilever door. These may be opened half or full height; they occupy no floor or apron space until half open; and they impose little strain upon the roof trusses—all essential considerations.

The three-story engineering building is a reinforced concrete structure 62 ft wide by 306 ft long with a laboratory wing 42 by 82 ft. Its air-conditioning system is of interest. This consists of two oil-fired heaters through which air is drawn from the outdoors, tempered, and supplied through a system of duct work to the various areas in the building. The duct work is divided into 14 zones, four zones to each of the first, second, and third floors, one to the basement, and one to the laboratory building. Air temperatures in these various zones are controlled by mixing dampers, allowing any proportion of air to be forced through the heater, or by-passed around it.

Cooling is obtained by means of direct expansion coils located at the inlet of the air-supply fans. By means of the mixing dampers the air volume to each zone can be effectively controlled to prevent undercooling during the summer period. This system has proved very economical from an operating standpoint, as is inherently the case with a direct-fired unit. Some difficulties, however, have been encountered because of extreme overcrowding in certain large areas, which require a low air temperature supply, and this in turn cools individual offices below the point of comfort.

Development of the military assembly building now called Building "C," but originally known familiarly as the French Building, is a dramatic story. During the winter of 1939 we received an order for 115 medium bombers from the French Government. As our existing manufacturing facilities were operating at full capacity with planes on order, we were required to provide a new manufacturing unit for the filling of this order.

As far as construction is concerned, the whole project started on January 23, 1939, when Mr. Martin asked me for a preliminary estimate of the cost of a building 685 ft long and 340 ft wide, with clear heights of 18 and 28 ft. Thereafter nothing more was heard until February 5, when he again called me in and asked for a detailed estimate. I was informed that acceptance of the bomber contract was contingent on our ability to construct a building of 400,000-sq ft area by May 1. This seemed an almost impossible task, but it was decided to go ahead.

First came the design. When Albert Kahn of Detroit was asked by telephone if he was in position to furnish plans quickly enough to start immediate construction he was much astonished, but agreed to undertake the project. How well he performed his part is attested by the fact that all plans, architectural and mechanical, were completed and competitive bids received on all except structural steel in the short space of three weeks.

On the following morning—Friday, February 6—Mr. Kahn and his staff appeared. In the meantime, we had

worked out the general plan, elevations, and a few details which permitted his staff to proceed immediately with the structural design. By working all Friday night, the structural steel contract was negotiated with the American Bridge Company at 2:00 p.m. on Saturday afternoon. Later that afternoon we let the excavation contract to the Williams Construction Company, of Middle River, Md., who agreed to move 83,000 yd of wet clay within an eight-day period. Before the week-end was over we had negotiated the electrical contract with Riggs Distler Company, of Baltimore, Md., and the furnishing of reinforcing bars, steel deck, steel sash, and hangar doors with the Truscon Steel Company. The following Monday (February 9) the masonry and carpentry contract was awarded to the Turner Construction Company, and the footings for the building were actually poured on February 16.

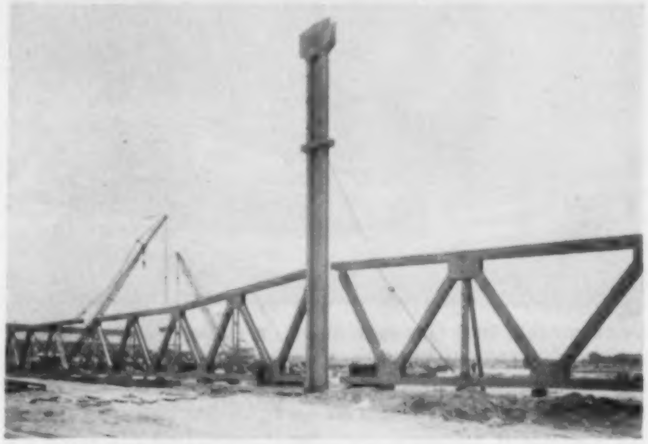
On February 6, at a joint conference of our Production, Tool, and Personnel Departments, a schedule was developed to meet their requirements. It was quite a task then to fix the schedule of material and operations so that a joint program could be made throughout the entire unit. But not one of the 34 contractors fell down on his commitment. Our only difficulty arose from the over-enthusiasm of a few who ordered their material delivered so early that it had to be rehandled. Especially was this true of the electrical fixtures contractor, who moved his material in four weeks ahead of schedule and had to take it back to Baltimore for storage until it was needed the first part of April. Speaking as of today, those of us who are trying to meet the present emergency would like to experience that difficulty again.

On April 23, which was 73 days after I was told to proceed with the work, the manufacturing area was under roof and well enclosed and installation of tools had begun. Actual manufacturing started on April 27. While the building was progressing, the production department had ordered a million dollars' worth of tools; it is a notable fact that they were ready for operation at the end of the seventy-seventh day. Thus we were not only setting a building record but a production record as well. The first airplane was flown within six months of the starting date, and the entire order of 115 medium bombers was completed 10 months and three days from February 5, 1939.

I must pause here to record every bit of tribute I can muster to the contractors on Building "C," who gave notice to the world at that time that industrial America could and would meet any challenge imposed under an emergency program. The fact that the subcontractors and material men called upon to do all but the impossible made every schedule exactly on time was an achievement that can never be adequately praised.

Following the Master Plan of 1928, the new unit was placed on the east side of, and adjacent to, the final assembly building ("B"). As the ground sloped east and south from the walls of Building "B" towards the river, the decision was made to keep the new ground, or first floor, on the same elevation and to provide a basement with a 14.0 ft-story height. This also resulted in a minimum of excavation for the basement area.

Building "C" is 685 ft long and 300 ft wide. In addition, where it adjoins the assembly building (that is, for 450 ft from the north end) there is a 40-ft two-story service bay, which brings the width to 340 ft. In the 685 by 300-ft basement, the concrete column spacing is 25.0 ft on centers both ways for the support of the first-floor flat-slab construction. The 10-in. concrete floor slab is designed for a live load of 250 lb per sq ft. Over the manufacturing area the steel roof frame is arranged to provide for monitors crossing the building in alternate bays. Above the first floor, the steel columns supporting the monitor-type roof are spaced 100 ft transversely and 50 ft longitudinally, except for the two south bays, where the longitudinal spacing is 108 and 125 ft. The west side of each of these two long bays is closed with cantilever-type canopy doors, similar in operation to the doors in the assembly building so that completed planes can be wheeled directly onto the concrete apron.



Erection of New "D" Building
First Steel Column in Place and Roof Trusses Being Assembled on the Ground

The 50-ft-span longitudinal trusses were arranged as 25.0-ft cantilevers projecting out on each side from 100-ft transverse trusses 12 ft deep. However, for a moving load of one ton anywhere along the bottom chord, the 50-ft trusses were designed for continuous action. An expansion joint was provided cutting the building into two parts. This joint was placed at midspan of the 50-ft trusses, with a toggle joint connecting the ends of the cantilevers.

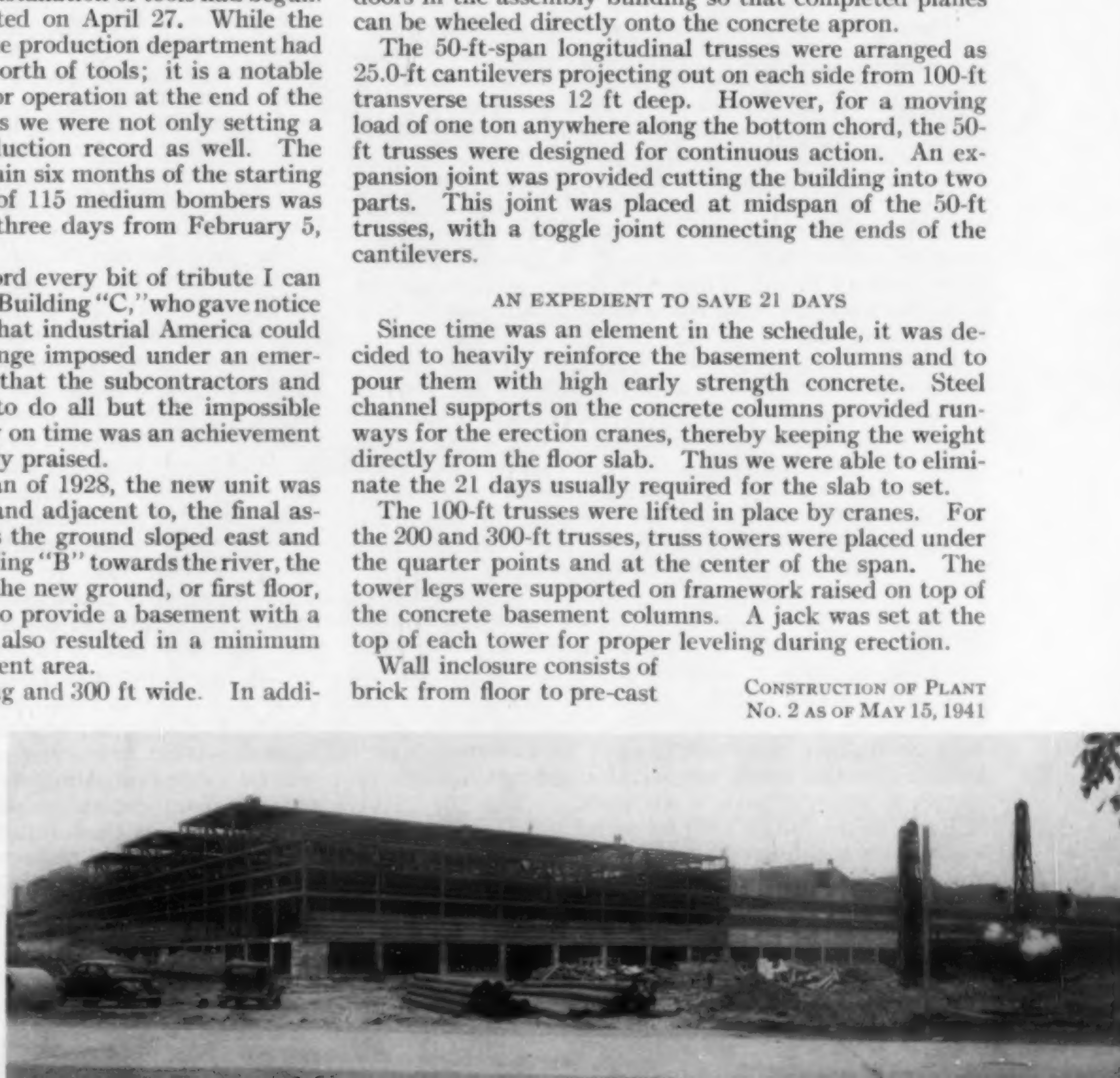
An Expedient to Save 21 Days

Since time was an element in the schedule, it was decided to heavily reinforce the basement columns and to pour them with high early strength concrete. Steel channel supports on the concrete columns provided runways for the erection cranes, thereby keeping the weight directly from the floor slab. Thus we were able to eliminate the 21 days usually required for the slab to set.

The 100-ft trusses were lifted in place by cranes. For the 200 and 300-ft trusses, truss towers were placed under the quarter points and at the center of the span. The tower legs were supported on framework raised on top of the concrete basement columns. A jack was set at the top of each tower for proper leveling during erection.

Wall inclosure consists of brick from floor to pre-cast

Construction of Plant No. 2 as of May 15, 1941



stone window sills and then alternate lines of continuous steel sash and gunite wall. Heat-intercepting glass is used on the east, west, and south sides; clear, on the north.

A factory building such as this requires extensive utility services—water, soil, compressed air, high- and low-tension power lines, and heat. Advantage was taken of the basement to hang such lines and conduits from its ceiling; thousands of metal inserts for pipe and conduit hangers were cast in the slab on 4.0-ft centers for this purpose. An 18 by 24-in. service outlet is left in the center of each 25-ft floor panel through which these services are brought to the production floor. While it is the practice in modern factories to place toilets on mezzanine floors above the production floor, in this building the toilets (7 in number) are on a mezzanine halfway between the basement and the first floor, easily accessible from both floors.

DRAWING SHOWING GENERAL VIEW OF PLANT NO. 2, A MILE AND A QUARTER FROM PLANT NO. 1
Initial Production Started in June 1941

Heating is by a hot-air system as in the assembly building; however, a reverse direction of air flow is used. Heat is supplied by five 50,000-cu ft per min furnaces, one in each of five furnace rooms in the basement. Hot air in metal ducts hung from the basement ceiling enters through floor grilles around the interior columns and is exhausted into the basement through floor openings along the walls, the basement acting as a huge plenum chamber. In addition, the aggregate area of exhaust openings is enough greater than the entrances to assure a positive flow of air to them. These two features of the design keep the warm air from rising into the roof, where heat is not required.

Special structural details are required at the columns to accommodate the hot-air inlets. Thus the tops of the concrete basement columns, which support the steel upper-story columns, are built with a well 2.0 ft square and 2.0 ft deep, into which the steel column base is set. Holes formed through the concrete column capitals connect this well with the hot-air ducts in the basement. The grilles through which air enters the production floor cover the annular space around the columns.

One discovery made at the time of construction of Building "C" has served us well in all the expansion that the Martin Company has embarked on since—a basement can be built at a small percentage of the overall cost of the entire building project, and is ideal for the manufacture of small parts. Practically everything we have built since that day has had its basement, and I believe that this lesson has been learned by the whole industry as an outgrowth of our work.

Early in the fall of 1940 we added 242 ft to the north end of this building ("C") and at the same time 225 ft to the north end of the assembly building ("B"). The original construction in both cases was carried through to the new north walls. The detailed connections, however, between columns and ends of the 300-ft trusses were altered to provide pins between truss and columns. The pins were placed on the column center lines opposite the truss bottom chord. Pairs of adjusting bolts connected the top chord of the truss to the top of the column; they were adjusted from time to time as the truss further deflected under the application of additional fixed loads, to relieve the columns from any bending whatsoever. Very little play ($^1/_4$ in. maximum) was permitted, so that the structure could still act as a fixed frame under a heavy wind reaction. Finally, after all dead load was applied to the truss, the connection between the top of the column and the truss was frozen to form a rigid bent.

Aside from its phenomenal construction schedule, Building "C" was notable for the experience it gave in this type of construction. Many of the lessons learned have subsequently been applied in other plant enlargements. These have included a personnel building, a new 400 by 1,000-ft Building "D," an extension on the engineering building, and an entire second plant separate from the one described, and totaling 1,200,000 sq ft of floor area.

One might logically inquire as to what is being manufactured in the Martin factories under the national defense and aid to Britain program. Three principal types of airplanes are being built, one for the Army, one for the Navy, and one for Britain.

For the Army, quantity production is already advanced on the B-26-1, a medium bomber which some rate as one of the world's most powerful airplanes. It carries a bomb load approximately twice that of its nearest competitor in the medium bomber field, is one of the most easily defended airplanes known, without a single blind spot, and travels faster than most of the pursuit planes now fighting in Europe.

Navy's PBM-1 patrol bomber is a long-range flying boat designed for mid-ocean patrol, and for operation either from a fixed base or with the fleet. An excellent rough-water ship, it carries living and galley accommodations for its crew for distant operations. Martin has finished up the first normal order of these flying boats and is now tooling Plant 1 for high quantity production of an improved model.

The new British 187 or "Baltimore" is already in production and the first ship is expected to be available the current (1941) spring. After that the company will produce these ships at a rapid rate.

Under the mass production program the Navy and British ships will be built in Plant 1 while Plant 2 will be devoted entirely to the production of the B-26. Plant 2 is being duplicated in all essentials at Omaha, Nebr., by the U.S. Army Engineer Corps. The Martin Company will operate as a Government agent for the assembly and subassembly of parts to be manufactured by the automotive and other non-aeronautical industries under the so-called Knudsen plan.

Even now it is problematical just what new development will be applied in any future expansion. Not many years ago any talk of future expansion was given only casual consideration. That seems to have been very long ago—and now future expansion must be adequately prepared for even in planning new projects. It is logical to assume that new items of construction development will be incorporated in future work. Construction for aircraft plant expansion will certainly develop in the same manner as the aircraft industry itself. What the future holds in this respect none of us can predict. It is certain, however, that the engineer will continue to advance in step with the requirements of industry.

Specifications and Plans of Ancient Times

By Richard Shelton Kirby, M. Am. Soc. C.E.

Chairman, Department of Engineering Drawing, Yale University, New Haven, Conn.

ONE sometimes wonders how much change has come over the engineer's habits of thought and work in the past forty or fifty centuries. One can only wonder, for on such matters very little information is available. Philosophers, theologians, and poets, in letters and even in confessions, have laid bare their innermost thoughts for posterity to argue over. Not so with engineers. Until lately even biographers have passed them by altogether. One sad result is that the world has forgotten even the names of the designers of many an ancient monumental structure.

While we come sensibly near to some of these ancient practitioners of engineering-architecture when we examine the structures they planned and built, we should come closer still if happily we had access to their original designs, that is, their specifications and drawings. But unfortunately merely a handful have been unearthed, and these not for the most important projects. What would one not give for a scrap of a scale drawing of the great Danube Bridge of 104 A.D. which Appollodorus pictured on Trajan's Column at Rome; or for an original profile of one of the too ambitious drainage projects in Italy or the earlier ones in Greece.

Writing nearly twenty centuries ago, Vitruvius, himself an engineer, insisted that members of his profession should be men of letters and skillful draftsmen. "In the writing of specifications," he counseled, "careful regard is to be paid both to the employer and to the contractor. For if the specification is carefully written, either party may be released from his obligations to the other without the raising of captious objections." Present-day specification writers aim at nothing higher—nor could they. In the same chapter of *De Architectura*, Vitruvius remarks that an engineer skilled as a draftsman will find it easy to produce a desired effect by colored drawings. Unfortunately the engineering and architectural drawings that undoubtedly adorned Vitruvius's treatise have not come down to us.

Parenthetically, Vitruvius the Roman drew a large proportion of his material from Greek sources, indeed he freely acknowledged the debt. It is only necessary to delve into the history of road building, of town planning, of drainage, and of water supply to realize the extent to which Roman engineers in these fields were inspired by the work of their Greek predecessors. The Greeks had more than words for such accomplishments.

A number of Egyptian documents, written in Greek on papyrus, are of engineering interest. For example here is part of a contract, dating from about 245 B.C., covering construction work in the Fayûm, a fertile region west of the Nile some miles above Cairo. Only about half of the document will be quoted.

"In the 2nd year of the reign of Ptolemy . . . on the . . . of the month . . . at Crocodilopolis . . . a contract was given out from the Treasury after public auction through Hermaphilus the aeconomus in the presence of Theodorus the engineer . . . for the following work:

"To take down the two bridges at Ker . . . and to lay facines along the . . . for a distance of 35 schoenia from the bend; to take down the bridge at Hiera Nesus and replace the facines against the underlying parts and make the opening at top 8 cubits in width . . . . [and so on with a dozen or more small bridges].

"On furnishing substantial sureties to the aeconomus he shall receive half of the fee for the contract, and when he has done work up to the value of the money given he shall receive the remainder. . . . There shall be supplied from government stores a sufficient number of mattocks, of which the price shall not be added to the account and which he shall return on completion of the work, weighing their original weight, and . . . which he shall transport for himself. If he fails to perform the work or to act in accordance with the stated terms, the official in charge of these matters shall be empowered to put up the work to auction again and to hire labor from day to day; and whatever additional sum it costs when resold or whatever is spent in hiring labor from day to day, this the contractor shall straightway forfeit together with the money which he has already received, increased by one-half, and the damages; and concerning himself the King shall give judgment. [Signed] Horus, nomarch,

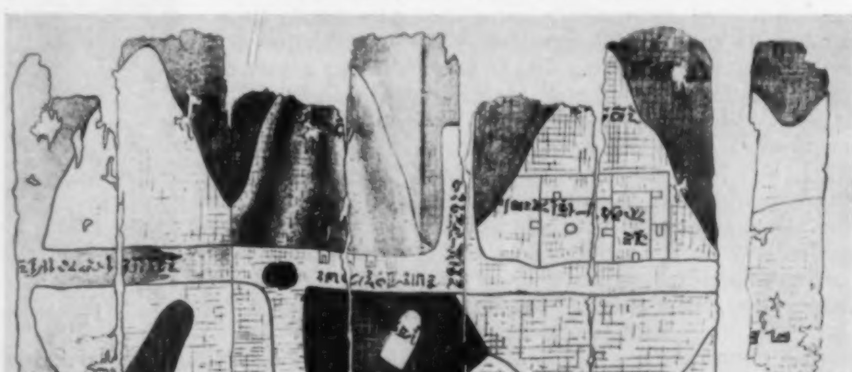


Fig. 1. "Gold-Mine Map," Drawn on Papyrus, Depicts Roads That Led from the Red Sea to the Nubian Gold Mines Fourteen Centuries Before Christ

From F. Chabas, *Les Inscriptions des Mines d'Or de Nubie*, in Bibliothèque Egyptologique, Paris, 1902

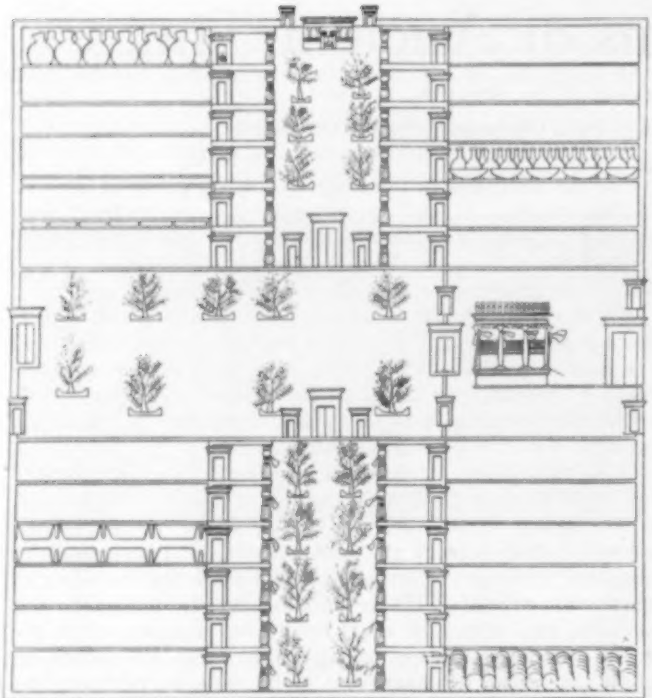


FIG. 2. AN EGYPTIAN ARCHITECT'S PLAN OF STOREHOUSES IN THE TEMPLE OF TELL EL-AMARNA

From Jean Capart, *Lectures on Egyptian Art*, University of North Carolina Press, Chapel Hill, N.C., 1928

took the contract." (Based on translation of A. S. Hunt and C. C. Edgar, *Select Papyri*, Vol. 2, London, 1934.)

A contract document of the fourth century B.C. was dug up in Greece some years ago, in practically perfect condition, and fortunately came into the hands of a scholar, Alexander Meletopoulos. The specification describes a marble building 400 ft long, built as a sort of naval storehouse or arsenal at the Piraeus, the port of Athens. The engineer-architect, Philon, who had the specification chiseled word for word on a stone slab nearly 4 ft long set in one of the walls, was, he thought, simply conforming to the accepted practice of his day in providing a document which would serve as a sort of final report to the citizens of the little Athenian state, naturally anxious to know how their hard-earned tax money had been spent. The arsenal stood for about three centuries, until it was destroyed by Sulla, ruthless Roman conqueror.

The entire document, the equivalent of perhaps four of our printed pages, is a model of explicit delineation. No more complete specification has yet been unearthed. It gives us something of an insight into the practical construction problems that confronted designers in the days of Diogenes and Aristotle, three centuries before Vitruvius penned his much quoted treatise. Some modern authorities insist that these specifications also furnish hints as to a body of occult knowledge of structural design possessed by the ancient Greeks but lost to the world many centuries ago. From the bits at the beginning and end of the document, it is obvious that there were subcontractors; also that Philon had provided a plan or model of the building to supplement the specifications. A translation of the document by Thomas W. Ludlow ("The Athenian Naval Arsenal of Philon," in the *American Journal of Philology*, 1882) follows:

[In the presence of] "the Gods.

"Specifications for [the construction of] the stone arsenal for naval tackle and rigging of Euthydomos, son of Demetrios of Melite, and Philon, son of Exekestides of Eleusis.

"An arsenal shall be built in Zeia for naval tackle beginning near the propylaeum which leads from the agora as one approaches from behind the ship houses which are roofed in together. The length [of this arsenal shall be] four plethra; its breadth shall be fifty feet, or fifty-five including the walls. The ground of the site must be cut down three feet where it is highest, and leveled in the other parts, and the foundations must be laid upon the firm ground, which must everywhere be made smooth and brought to a true plane by [the use of] the level. The foundations for the columns must be laid at the distance from the walls of fifteen feet, including the diameter of the columns. The number of the columns of each row shall be 35; [and the rows shall be so arranged as] to leave a passage for the people through the middle of the arsenal. The width [of this aisle] between the [two rows of] columns shall be twenty feet. The thickness of the foundation shall be four feet, and the stones shall be placed crosswise . . . and lengthwise. The walls and the columns of the

FIG. 3. PARTIALLY DIMENSIONED DRAWING, WITH LANDSCAPING, FROM THE RUINS OF THEBES, 1500 B.C.

Wood Tablet Now a Prized Possession of the Metropolitan Museum of Art, New York

arsenal shall be built of the stone of Akte. A directing-course shall be laid for the walls, ...

"The chests placed against the wall shall be made to open in front, and those against the columns to open at each side, in such a way that it may be possible for those passing through [the arsenal] to see all the tackle that is in the arsenal. That there may be ventilation in the arsenal, when the courses of the walls are laid,

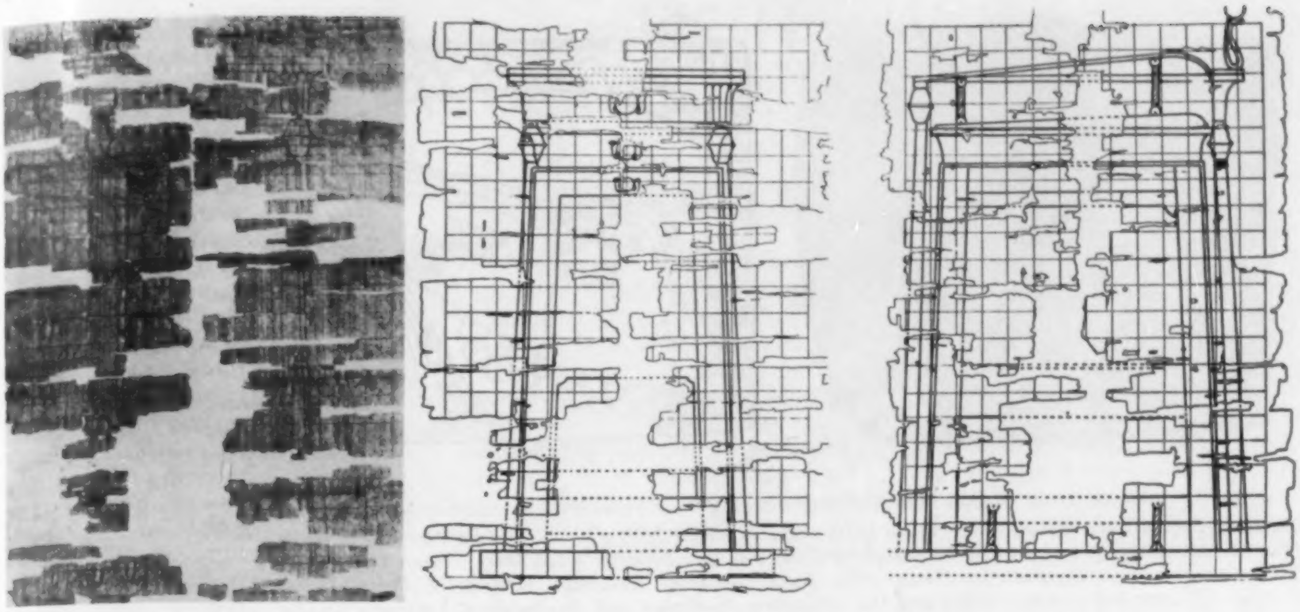


Fig. 4. From Egypt in the Time of Moses Come These Working Drawings of an Elaborate Wooden Shrine

Note Square Ruled Background and Front and Side Elevations, Only One of Which Appears in Photo. Photo from Flinders Petrie, "Egyptian Working Drawings" in *Ancient Egypt*, March 1926; Sketches from Clark and Engelbach, *Ancient Egyptian Masonry*, Oxford University Press, London and New York, 1930

[spaces] shall be left open at the joints of the blocks wherever the architect shall direct. All these things shall be carried out by the contractors in accordance with the specifications, following both the measurements and the plans which the architect shall indicate; and they shall deliver each detail of the work within the time to which they shall have agreed in the contract."

In this connection engineers will also be interested in William Hovgaard's paper, "The Arsenal in Piraeus and the Ancient Building Rules," which appeared in *Isis*, 1926.

At a still earlier period the engineer-architect, whatever his title may have been, seems to have expressed his ideas largely in the form of drawings, supplemented by an occasional note. The drawings that have survived until our day are scattered throughout the world's great museums. Seven of the best known are depicted and briefly described here.

A map of perhaps the 14th century B.C., which is now in a museum at Turin, Italy, is shown in Fig. 1. Drawn on papyrus, it was originally tinted in several shades. It has been known as the Gold Mine Map, for it shows roads leading from the Red Sea to the infamous gold mines in Nubia. The lower road is apparently indicated as being marked out by seashells. A cistern appears near the center of the sketch; a few houses are shown, and there are notes telling which are the gold-bearing mountains. This map, with somehow the flavor of a pirate's sketch, might illustrate a story like *Treasure Island*.

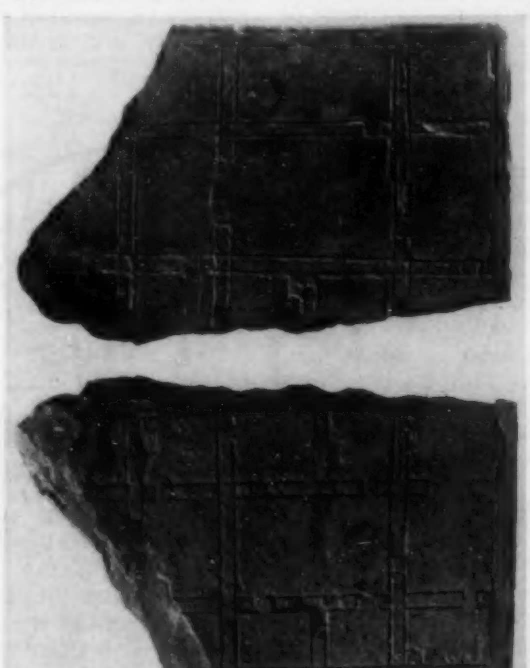


Fig. 5. A Sumerian House Plan Five Hundred Years Older Than the Code of Hammurabi

From Henri Frankfort, *Oriental Institute Discoveries in Iraq, 1933–1934*, Communication No. 19, The Oriental Institute of the University of Chicago, 1935

Plans of houses and grounds were not infrequently drawn on the inner walls of the tombs of the more opulent Egyptians. One would be tempted to assume that this was done either for the edification of the deceased while he was still in the flesh, for posterity in general, or simply as an egoistical gesture on the part of the designer. In the Middle Kingdom, nearly twenty centuries before Christ, small clay models were placed in tombs. All of these, Egyptologists believe, were to serve by "sympathetic magic" as houses for the dead in the underworld. Some scholars reluctantly admit, however, that such models may occasionally have been prepared during an owner's lifetime to help him and his wife visualize the architect's drawings of their prospective terrestial residence.

An Egyptian architect of King Tut's time would depict a plan of the gardens of one of the country's nabobs. Or he might draw a plan view of a building with interior courts, like Fig. 2, which is a line sketch traced from an original drawing showing storehouses in the Temple of Tell el-Amarna. Note the brilliant idea of showing the trees and other upright features lying flat. Sometimes they were pushed over away from the center in four directions, or even eight, counting the corners. I vaguely recall seeing prone trees (all parallel) on an old nineteenth century American map.

All that remains of a somewhat similar drawing dating from about 1500 B.C. is in New York's Metropolitan Museum of Art (Fig. 3). It was dis-

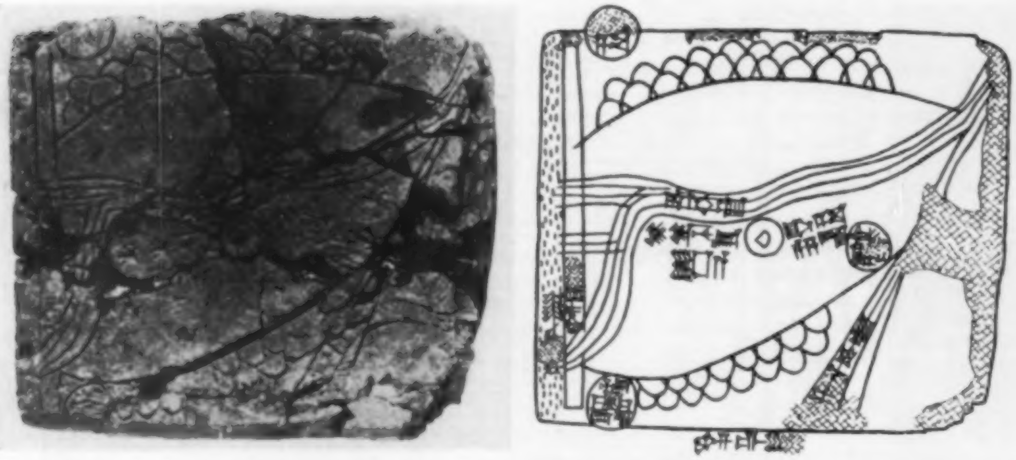


FIG. 6. PROBABLY THE OLDEST MAP YET DISCOVERED, WITH SIMPLIFIED RENDITION AT RIGHT
Imprinted on a Clay Tablet Some Three Inches Square About 2600 B.C. Note Two Rivers or Canals, Two Mountain Ranges, and Cities Indicated by Circles as on a Modern Road Map. From T. J. Meek, *The Akkadian and Cappadocian Texts from Nuzi*, Bulletin, American Schools of Oriental Research, December 1932; and *Old Akkadian, Sumerian and Cappadocian Texts from Nuzi*, Cambridge, Mass., 1935

covered in 1913 among the ruins at Thebes. The architect took a wooden writing tablet about two feet square and covered it over with a thin stucco on which he drew skillfully in black and red ink. The drawing is partially dimensioned; in this it is decidedly unique, for dimensioned drawings did not come into general use until the days of the Italian Renaissance. It seems to depict either an estate—real, imaginary, or projected—or the entrance to a temple. The scale is thought to be about one-eighth of a finger breadth to the cubit, or 1:225. The foreground is obviously a body of water.

Some years ago the late Professor Flinders Petrie, British Egyptologist, discovered among an assortment of torn papyri some fragments which, pieced together and mounted, formed a nearly complete architect's drawing (Fig. 4). The original sheet was 22 by 60 in. and the drawing dates, he believed, from the 18th Dynasty, roughly from the time of Moses. It was evidently a working drawing of an architecturally elaborate wooden shrine, such as would be carried in ceremonial processions. The front and side elevations are drawn against a background of cross-section lines ruled in red ink. (The photograph shows only half of the papyrus documunt, the front elevation.) This method of drawing on a square-ruled background was at least as common with the Egyptians as it is with us; in a sense it made dimensioning unnecessary. One wonders how many of our drawings will be legible in 5700 A.D.

Many centuries before Babylon or Nineveh, there lived in the Tigris and Euphrates valleys a people we call the Sumerians. They were among the earliest people to have a system of writing of any sort, and to build permanent homes instead of wandering about. The house plans of that day and for centuries afterward were drawn on clay tablets, most of them small enough to fit into the palm of the hand. One such tablet dating from about 2500 B.C., or 500 years earlier than Hammurabi, is shown in Fig. 5. It was recently discovered by a University of Chicago expedition. The architect was economical in this case, and so used both sides. Note that the doorways in this building of sun-dried brick were as wide as the walls were thick. One might estimate that the scale of the drawing was of the order of 1:120. The tablet was found at a place now called Tell Asmar, just east of Baghdad, in Iraq.

What is thought to be the oldest map yet discovered is shown in Fig. 6. It was unearthed ten or eleven years ago at Nuzi in northern Mesopotamia by the Harvard-Baghdad School Expedition. The map was drawn about 2600 B.C. on this tablet some 3 in. square. On it are depicted several cities (indicated by circles as on a modern road map), two rivers or irrigation canals, and two mountain ranges. It seems to have had some connection with business transactions; perhaps an estate manager carried it around, or it may have marked out a traveling salesman's route. The top of the map is not north, but east. The simplified rendition shows mountains to the east and west, and a river with several tributaries running through the center. The original is in the Iraq Museum at Baghdad; a cast is in the Semitic Museum at Harvard.

Of unusual interest and great antiquity is an architect's drawing defining a curve by coordinates, Fig. 7, which dates probably from the Third Dynasty (2900 B.C.). It is on a piece of limestone little larger than one's hand. The curve represents perhaps an archway of about 17-ft span and 6-ft rise. The dimensions seem to be equally spaced ordinates from a horizontal chord, and are expressed in cubits, palms, and digits.

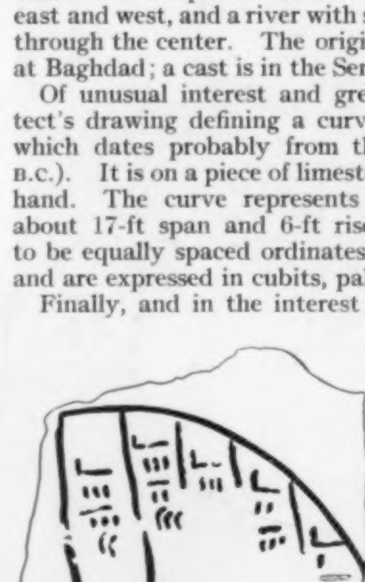


FIG. 7. DIAGRAM OF AN ARCHWAY, DEFINING A CURVE BY COORDINATES
Work of an Egyptian Engineer Who Lived About 5,000 Years Ago. From Clark and Engelbach, *Ancient Egyptian Masonry* (*See Fig. 4*)

Finally, and in the interest of accuracy, it might be well to qualify our statement that ancient engineers were not addicted to autobiography. At least one Egyptian member of the profession, Ineni, left his own personal estimate of his achievements inscribed on the walls of his tomb. Perhaps King Solomon, who must have had many an argument with architects, had heard about Ineni when he wrote, "Let another man praise thee and not thine own mouth, a stranger and not thine own lips." For Ineni boasted "I became great beyond words. I did no wrong whatsoever. I was foreman of the foremen. I never blasphemed sacred things." Very evidently this would now be a technical violation of Section 6 of the Code of Ethics of our Society, which, however, makes no mention of posthumous offenses. Some modern commentator has remarked that if Ineni, in dealing for years with oriental labor, had never blasphemed, he must indeed have been a paragon of self-control.

TVA Demountable Houses Solve Construction Camp Problem

By Carroll A. Towne

Chief, Division of Recreation and Public Grounds, Tennessee Valley Authority, Knoxville, Tenn.

Building a camp cottage in slices, in a large shop, transferring it by trailer to the construction job, and reassembling it in a few hours—this is the TVA solution for the problem of workmen's quarters that must be moved every few years. The key to the scheme is the use of pulley wheels supporting the sections on a simple pipe track. Thus the parts are built originally, bolted together at the factory, then separated, transported, and threaded together again, to assure perfect fit.

Dam sites have a way of being located in some of the most remote and sparsely settled sections of the country. Seldom do they lie within commuting distance of an ample supply of resident labor or within access to adequate housing for migrant workers and supervisory personnel. Employee housing is thus a major problem preliminary to the construction of nearly every large-scale river-control project.

For the past eight years the Tennessee Valley Authority has been building dams on the Tennessee River and its tributaries. To date six dams have been completed and placed in operation; four more are currently under construction. At all but two of these ten projects it was necessary for the Authority to provide housing.

The Authority has long felt the need for a type of employee housing that could be moved from one project to another—a type that would combine the shelter afforded by a conventional frame house with the mobility of an automobile trailer. Such a type of housing was designed in 1934 by Louis Grandgent, then an employee of the TVA and now with the U.S. Housing Authority. His "truckable unit house" called for the building of a complete house in demountable sections in a central plant, and transportation, section by section, to the construction project. When the job was over, the house could be transported in sections to the next project.

Unfortunately, the urgent need for employee housing in the early days of the Authority's construction program did not permit experimentation with novel techniques, and the demountable house plans were buried in the files until an opportunity to test them appeared during the past winter. This was in connection with the Authority's program for recreational development of properties along the margin of reservoirs. Recently there developed a need for six summer cottages on the shore of Pickwick Lake near the dam. At the same time, the Authority learned that it was to act as the agent for the Federal Works Agency to construct 250 houses for defense workers in the nearby Muscle Shoals area. The problem of providing housing for defense workers is in many respects similar to that of providing housing for dam construction workers: frequently the need is relatively temporary.

Immediately the six summer cottages for Pickwick Park became the guinea pigs for the Muscle Shoals defense houses, 150 of which are of the demountable type. Using the original Grandgent principles, with a

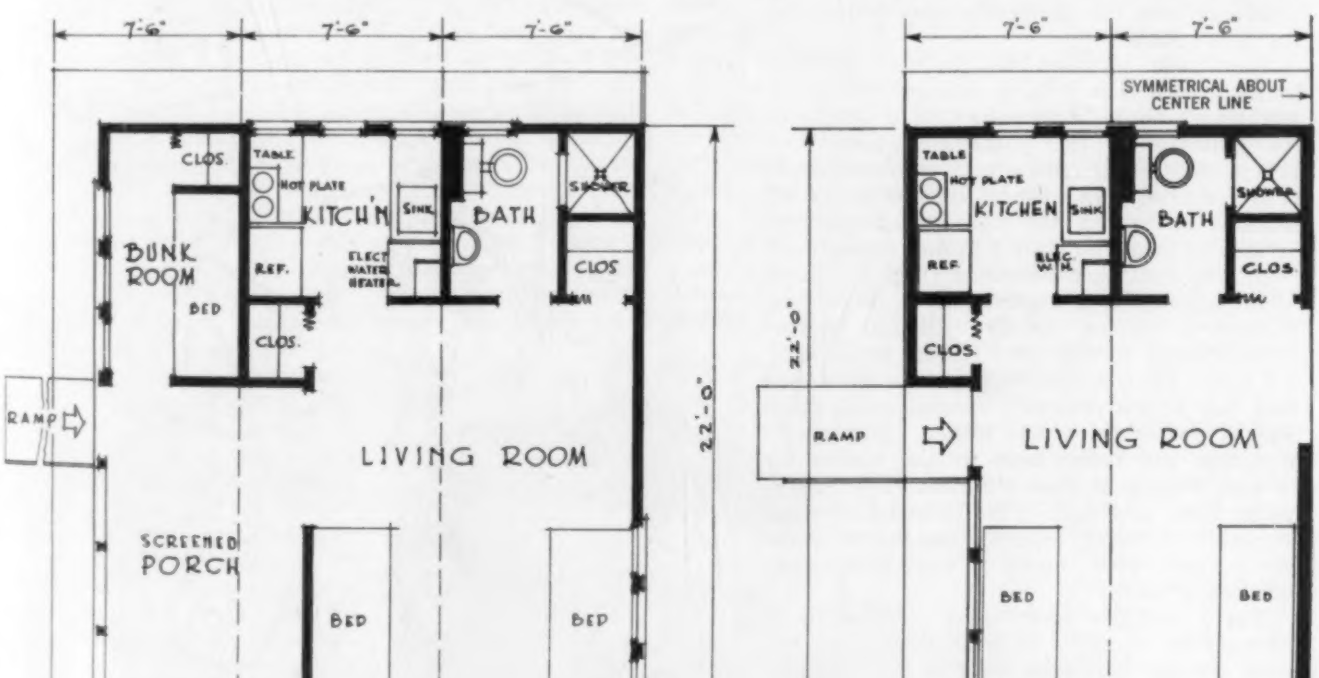


Fig. 1. Plans of Pickwick Cottages—Left, Single Family; Right, Duplex

Assembly Line in TVA Shop, Sheffield, Ala.
Cottages Were Erected in Completed Form and Unbolted for Transportation in Sections

few modifications of construction details, two single-family cottages and four duplex cottages were built in an idle shop on the Authority's nitrate plant reservation adjacent to Sheffield, Ala., in the heart of the Muscle Shoals area. As the cottages were completed, they were trucked in separate sections to Pickwick Park and reassembled.

The demonstration was successful. Not only has the plant been expanded to facilitate the construction of 150 demountable defense houses, but plans are being drawn for the application of the principle to dormitories, dining halls, and other construction camp buildings that the Authority may require in the near future.

The basic element of the demountable building—whether it be a summer cottage, a workman's house, a dormitory, or a community building—is the portable section. For practicability and economy in transportation, it is essential that over-all dimensions of all sections be within the clearance limits prescribed by local and state highway regulations.

In the Pickwick buildings (Fig. 1), three sections comprise a single-family cottage, four sections a duplex cottage. Overall dimensions of every section are 7 ft 6 in. by 22 ft by 9 ft 6 in. Each section weighs about three tons and can be conveniently carried on a lightweight two-wheel truck trailer. Similar dimensions are being used in the houses for defense workers at Muscle Shoals. The framework, floor, and roof of the Pickwick cottages are made of wood; exterior and interior walls are covered with sheets of weather-resistant insulation board.

These cottages have been referred to as "houses in slices." It is as though a complete cottage had been built in one piece at the factory, sliced into sections to permit moving, and reassembled on the site. In effect this is what is done, inasmuch as each cottage is constructed in the shop as a unit, but with the sections bolted together. When a cottage is finished, the sections are separated, moved to the site, and reassembled. This unique method of construction insures a perfect fit between sections.

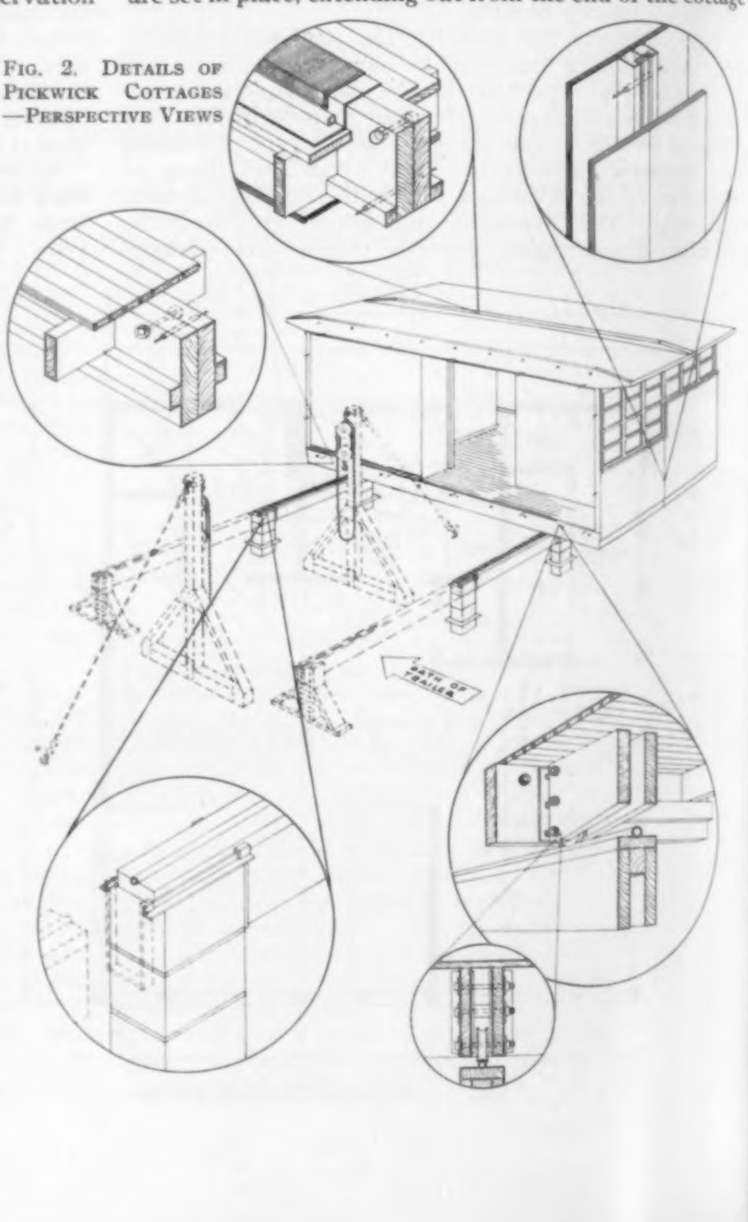
In construction, the assembly-line technique is employed. Standardization of design and centralized shop production permit the use of power-driven tools and efficient organization of the work. The cottages were built entirely from stock materials used in the same fashion as in standard practice.

Wheels Make Cottages Demountable

A set of four wheels, one near each corner, is permanently mounted in the floor frame of each section (Fig. 2). Stock sheave pulley wheels, $4^1/_2$ in. in diameter, with $^5/_8$-in. bolts for shafts, are used. Although a small detail in the finished product, these wheels are what makes the cottage demountable. As the section progresses through the various stages of assembly, it is moved along a track that is as simple as the wheel arrangement. The track is a pair of ordinary 1-in. galvanized iron pipes fitted on a frame assembly rack. Three workmen can easily roll an entire cottage to any place on the line.

When the cottage is completed, the section nearest the delivery end of the assembly line is unbolted and hoisted onto a two-wheel truck trailer. Upon delivery at the site, the section is hoisted above the trailer, which is then driven out from under it. Temporary tracks are set in place, extending out from the end of the cottage

Fig. 2. Details of Pickwick Cottages—Perspective Views



foundation to removable supports, and the section is lowered onto this track and rolled to its proper place on the foundation. The hoisting device is portable, and consists of a pair of well-braced posts about 8 ft high, each of which supports a small chain hoist. Two men operating each hoist can readily lift a section and keep it balanced until it is ready to be lowered.

Thus the Pickwick cottage achieves mobility. It is not a "temporary" house to be used for a few years and then salvaged. It is a durable house with the added quality of mobility.

When ready for delivery, the sections of a Pickwick cottage are virtually ready for occupancy—only the furniture is lacking. About 12 to 16 hours are required to build a section in the shop, and it is believed that this time could be substantially reduced as workmen become more familiar with the job. No unusual skills or techniques are required; the men employed are principally carpenters, plumbers, and electricians, who work at their appropriate trades at prevailing wage rates.

Of course, certain work cannot be done in the assembly plant but must be done at the site—joining the sections together, and connecting the house services with the local water, drainage, and electric systems. Foundations for the Pickwick cottages are piers of pre-cast cinder blocks set on concrete footings poured in place. A concrete core is poured in each cinder block after it has been placed. Prefabricated beams are suspended between the piers, and the permanent tracks, on which the cottage finally rests, are set on the beams.

Bolts connect adjoining floor and roof girders, but not the walls. Instead, mesh pins in adjoining exterior walls and floors serve two purposes: they serve as guides in matching adjacent sections as they come together, and they prevent wall sections from moving out of true plane after the assembly has been completed. Roof joints are protected by galvanized iron flashing; wall joints are sealed with wood splines. With four men working, it takes less than an hour to join two sections.

It should be emphasized that no difficulties were encountered in trucking the sections from the plant at Sheffield to Pickwick Park. The distance is about 60 miles, the last 20 of which are over a gravel road through hilly country. Normal driving speeds were maintained and the truck covered the distance in about $2^1/_2$ hours. It had been feared that the sections might be racked in transit, but this fear was completely allayed. No difficulty arose from width and height clearances.

Placed in the attractive sylvan setting of Pickwick Park, the cottages present a very pleasing appearance. They are of modern design and are painted in harmonizing shades of gray, green, and brown that blend well with the natural setting. Designed for summer occupancy, the cottages are bright and airy. The duplex building, consisting of four sections, is essentially two apartments, one the reverse of the other. In the single-family cottage, two sections identical with those used to make up one of the duplex apartments are supplemented by an additional unit containing a small bunkroom and a screened porch.

A Section En Route—Three-Ton Weight Easily Hauled on Light Truck

For the 150 demountable houses for the Muscle Shoals area, a similar type of building has been approved by the Federal Works Administrator. The general appearance is like that of the average small house. Fifty one-bedroom, 50 two-bedroom, and 50 three-bedroom houses are being built. The standards set by the Defense Housing Coordinator regarding room sizes, closet space, structural specifications, and other details are being met.

Assembled in Place in Pickwick Park with Ramp Added
Only Water and Electric Connections to Be Supplied

Comparison of the costs of providing employee housing by conventional methods and by demountable methods is illuminating. The average time required for the construction of each of the Authority's eight dam projects has been between three and four years. It has proved difficult to provide housing of the required standard within costs commensurate with the relatively short period of occupancy. Among the various solutions tried by the Authority, those at Hiwassee Dam, in western North Carolina, and Kentucky Dam, near the mouth of the Tennessee River, are most related to the present subject.

At Hiwassee Dam the Authority erected workmen's houses of satisfactory standards (as prescribed by the Committee on the Hygiene of Housing, American Public Health Association) at genuinely low cost. Family units ranged in cost from $900 in duplex houses to $1,000 in single-family houses. These costs, like all others used in this article, include labor and material but not overhead. Economies were effected through simplicity of design, quantity construction, and the use of weather-resistant wallboard which permitted savings in both material and construction costs. The maximum life of the houses as required by the Authority's program needs was four years. It is interesting to note, however, that upon completion of Hiwassee Dam most of the houses were purchased by private bidders, at prices of around $100, and were dismantled, removed to other sites, and rebuilt for further occupancy.

When the Kentucky Project was started, the housing problem was approached from the standpoint of re-use. Seventy-two workmen's houses in the construction village of the completed Pickwick Project were vacant and the Authority moved them to Kentucky Dam village, a distance of some 200 miles. Inasmuch as both villages were on the shores of the lower reaches of the Tennessee, it was possible, with the aid of controlled discharge from Pickwick Dam, to move the houses by barge.

TRANSFER BETWEEN PICKWICK AND KENTUCKY DAM SITES, THROUGH PICKWICK LANDING DAM LOCK
In All 72 Houses Were Thus Moved

Undoubtedly, such an extensive mass movement by land would have been prohibitively expensive. As it was, the cost of moving the houses, placing them on new foundations, and reconditioning them averaged $1,280 per house. While the operation was successful in view of the fact that the houses were 3-, 4-, and 5-room frame houses originally costing about $2,000 to build, approximately one-fourth of the moving cost resulted from reconditioning of houses that had been racked or otherwise damaged in transit.

In addition to houses, the Authority has built dormitories, dining halls, recreation buildings, hospitals, and other necessary structures at its various construction communities. When the need for these buildings ceases, all fixtures and equipment, window and door frames, and miscellaneous material are salvaged for use in subsequent construction camps. Salvage of lumber, however, has proved to be impractical, and high bids on the lumber from a $12,000 dormitory have been as low as $50.

Had the houses originally provided at the Pickwick construction village been of the demountable type, apparently they could have been moved to Kentucky Dam at an average cost of $650 each, including new foundation and reconditioning as well as transportation. The big difference between the hypothetical $650 and the actual $1,280 cost of moving the rigid-frame houses lies in methods of loading and unloading and in the amount of reconditioning necessary after the moving, which in the case of the demountable houses would be only that required by normal wear and tear during the initial period of occupancy. Carefully moved demountable sections should suffer no damage in transit, while the same cannot be said of the unwieldy frame house. The costs of moving alone, exclusive of loading and unloading, are relatively low for either type of house—$230 for the Pickwick houses moved via barge and $275 for the demountable houses moved by truck. This ratio would not hold, of course, if river transportation had not been available for the former.

In analyzing the economic advantages of the demountable house versus the usual one-piece house, a clear distinction must be made between demountability and prefabrication. Prefabrication is a method of construction: demountability is a principle to which that method is applied. Although the Authority's demountable houses are prefabricated and may, as shop production methods are improved, be built more cheaply than by standard methods, no claims for savings in initial construction costs will be made until experience records have accumulated. Such evidence as is at hand, however, indicates that the cost of building a demountable house in a shop, moving the house to a site within a 25-mile radius, and assembling it, would be no greater than the cost of building a similar house by conventional methods on the site.

Be that as it may, the Authority's claim for economic advantages of demountability, as distinguished from prefabrication, lies not in any savings of providing a house for initial occupancy, but in providing a house for re-use at a number of different sites. A third alternative, erecting new buildings, was chosen for the dormitories at Kentucky Dam. Standard TVA workmen's dormitories accommodate 60 men each and cost about $12,000. Because of their size, moving them any great distance, whether by barge or by highway, is practically out of the question. Yet a 60-man dormitory built in demountable units could be moved the 200 miles from Pickwick to Kentucky for about $4,500. These calculations are, of course, subject to considerable refinement, although they are based on the actual experience of moving 22 cottage sections from Muscle Shoals to Pickwick Park.

NEW CONCEPT OF HOUSING BEING EVOLVED

Although undoubtedly there are many improvements that can be made in the demountable system developed by the TVA, the basic principle appears to offer a solution to at least a part of the problem of providing housing for construction workers and other temporary residents. Just how far the principle can be applied to the solution of many of the nation's housing problems remains to be seen. Many other innovations in housing today offer great promise.

Out of the housing experiences of the Authority, of various housing agencies of the Government, of the architects, builders, and manufacturers—all of whose efforts are being greatly accelerated by the national defense program—there is evolving a new concept, revolutionary in its implications, that will have a permanent effect on the techniques of housing the workers of the nation. The time is near when the gap between the automobile trailer, ideal for vacations but substandard on many counts as a family home, and the complete house, now desired by all but so far from the reach of many, will be closed by that technological curiosity—the demountable house.

HOUSE MOVING BY RIVER—PREPARING TO HAUL STRUCTURE UP THE HILL AT KENTUCKY DAM SITE. ROAD HAD TO BE PROVIDED

Road Work in Theaters of Military Operations

Part III. Bridging Considerations

By Robert H. Burrage
Major, Corps of Engineers, U.S.A.

DESIGN refinements on bridges constructed under fire are hardly to be expected. But it is encouraging to know that the dog-eared formulas of 1918 have been revised and replaced to take advantage of the most recent civilian practice. The portable steel bridge, too, is a welcome innovation, certainly a vital need for any armored element that may find itself doing a blitz campaign in one of our barren, untimbered, and unsettled regions. Major Burrage's article is the final one of this series, arranged through the cooperation of the Chief of Engineers of the Army.

IN an earlier article in this series on "Road Work in Theaters of Military Operations," Col. S. C. Godfrey, M. Am. Soc. C.E., stated that "manifestly, a road is no stronger than its weakest link, which exists usually at a stream crossing." In any theater of operations the roads and the railroads, the lines of communication, are the arteries through which must flow the life blood of the army, the men and materials which are the army; and the stream crossings and other bridges are the most vulnerable points in these arteries. In any battle zone the roads occasionally will be destroyed or blocked at critical points, and constantly will be subjected to punishing treatment; but the bridges, large and small, will be thoroughly wrecked. If there is any one thing that may be taken as an axiom by the engineers, it is that the number of bridges they must reconstruct in war will be more or less identical with the number of crossings in the road net, plus a few more, as some of these will be again destroyed.

The tremendous extent of the bridging task placed upon modern engineering troops is indicated by reports of one of the German armies, which on its rapid advance to the west in 1940, in a period of only eight or ten weeks constructed 183 emergency bridges (exclusive of railway bridges), from 80 to 1,300 ft in length, with capacities of from 16 to 24 tons, as well as 57 ponton bridges. That accomplishment was the result of several factors. There was speedy evaluation of construction possibilities, accurate judgment as to the repair possibilities of damaged bridges, and good organization in the procurement and transportation of material. There was thorough planning of every step, and finally there was the performance that can come only from thorough training and high morale.

During the World War the bridging tasks to be undertaken by the engineers of the A.E.F. were fairly well defined. The theater of operations had been fixed for several years; the road net was a settled one; it was certain that most bridges would be "out"; and there was available at least some information on the critical features of the streams to be crossed. It was therefore comparatively simple to foresee the task, to estimate the probable requirements of materials, and to assign suitable engineer units. The problem was reduced to that of overcoming physical obstacles and frequently of overcoming the handicap of enemy opposition. Today, with the possible theater of operations unknown, the bridging task is by no means so clearly defined.

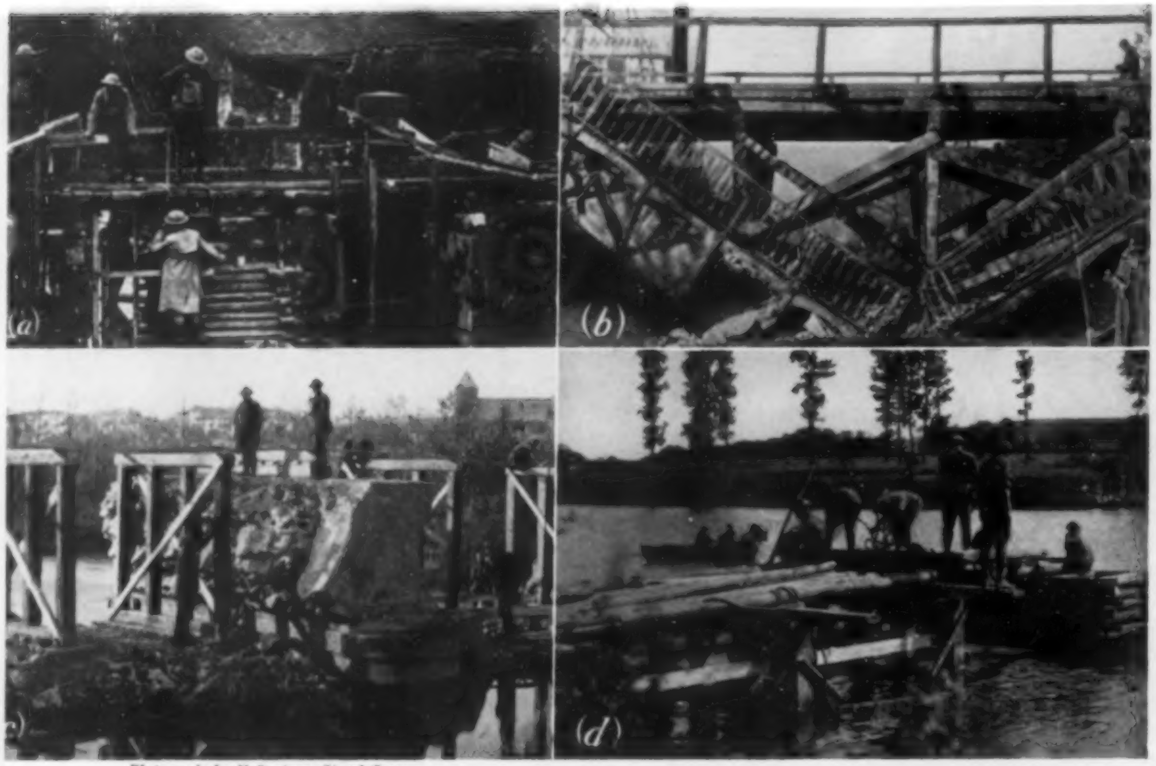
Photographs by U.S. Army Signal Corps

Two Hours' Work in Complete Darkness
Repair Made by 27th Engineers Under Fire at Bourevilles, France

In general the doctrine of military engineer operations has been that any engineer troops in the forward areas should be able to perform any of the tasks which may be encountered, but at the same time an endeavor has been made to provide special units for those tasks requiring either a special skill or special equipment. The divisional engineer units, accompanying the attacking forces at the very front, must keep pace with the advance, so cannot be encumbered with heavy equipment; they are more likely to be under enemy observation and fire, so cannot execute a complete or refined structure. Their task is to do only the minimum necessary to permit the advance of the division, involving perhaps the construction of rafts, ferries, footbridges, and other hasty arrangements for the passage of forward echelons and combat trains.

Two-Way Bridge Constructed in 2 Days, 15 Hours
Span 188 Ft Long Built by 27th Engineers for 20-Ton Loads
Remained in Service Five Years—Meuse River at Vilosnes, France

In accordance with that theory, as the advance progresses, the divisions on the line are followed successively by the Corps and Army troops. The Corps Engineers, less involved in combat and better equipped to handle heavier tasks, construct ponton or trestle bridges that will carry the heavier loads of the corps. They will also repair the roads. The Army troops have the task of improving all facilities, extending the rail heads, constructing semi-permanent bridges, and carrying all maintenance. This procedure, however, is very flexible, and the nature of the situation or the terrain may require the use at the front of the special facilities or abilities of the Corps or Army troops.



Photographs by U.S. Army Signal Corps

TRESTLE AND CRIB CONSTRUCTION IN FRANCE, 1918

(a) Salvaged Lumber in a Bridge East of St. Souplet. (b) Wreckage Can Be Useful. (c) Destroyed Three Times, Rebuilt Under Shell Fire—Grandpré. (d) 6th Engineers on the Marne near Mezy

In the A.E.F., for example, a corps mining regiment, being naturally fitted for the work, was called forward to construct observation posts overlooking enemy positions along the Vesle; and in the Argonne, where the Meuse River was a formidable obstacle, the army heavy-bridge regiment operated all along the front.

During the World War the heaviest loads to be carried by the army did not exceed 20 tons. The fixed bridges (the use of floating bridges by engineer troops has been discussed in another article of this series) built by engineer troops in the zone of advance were restricted to those using wooden trestle, crib or pile supports, employing of course any existing piers or abutments. Stringers likewise were usually of heavy timber, although steel rails or salvaged truss members were occasionally used. Practically no power tools were available, and no special equipment other than improvised pile-drivers or gin-poles.

The performance of our engineer troops under such restrictions was noteworthy, and may be illustrated by two examples. In one case a demolished stone arch with a span of approximately 30 ft was replaced by a wooden structure, crude but good for a 15-ton load, in less than two hours' time, although built under shellfire and in complete darkness. In the second case, where the crossing involved a 60-ft creek, a river 188 ft wide, a 24-ft canal, and a 30-ft mill race, a more pretentious job was done, providing a two-way structure, 12 ft above 8 ft of water, and designed for a 30-ton load. The construction required 2 days and 15 hours, and the bridge remained in service on a main highway for five years following the war.

Today the mechanization of armies and the development of blitzkrieg tactics have brought a tremendous increase in speed; the result, as it affects the engineers, is more vehicles and heavier loads—getting forward sooner. The diversity and the range of the loads involved in moving a modern army are indicated in Fig. 1, which shows typical wheel and axle loads.

To balance the scales in some degree there have been corresponding improvements in material and technique; the engineers now can call on the Air Corps for photographic reconnaissance of inaccessible bridge sites; they now are equipped with motorized air-compressors, tractors, bulldozers, power earth augers, power shovels, pile drivers, power saws and drills, while personnel carriers conserve the time and energy formerly dissipated in long marches.

An aggressor nation starts, of course, with an advantage, for it knows exactly where its theater of operations is to be; it has ample opportunity for extensive reconnaissance and preparation in time of peace; and it will not strike until every detail is ready. In the German invasion, there is reason to believe that there had been considerable advance design and indeed that even before the war began some of the bridges for use in the invaded countries had been fabricated in sections for specific crossings.

On the other hand, should we become involved, there is no certainty as to the locale, and specific preparation is out of the question; we must be prepared for a wide range of possible conditions. It is probable, however, that the great majority of bridges which may have to

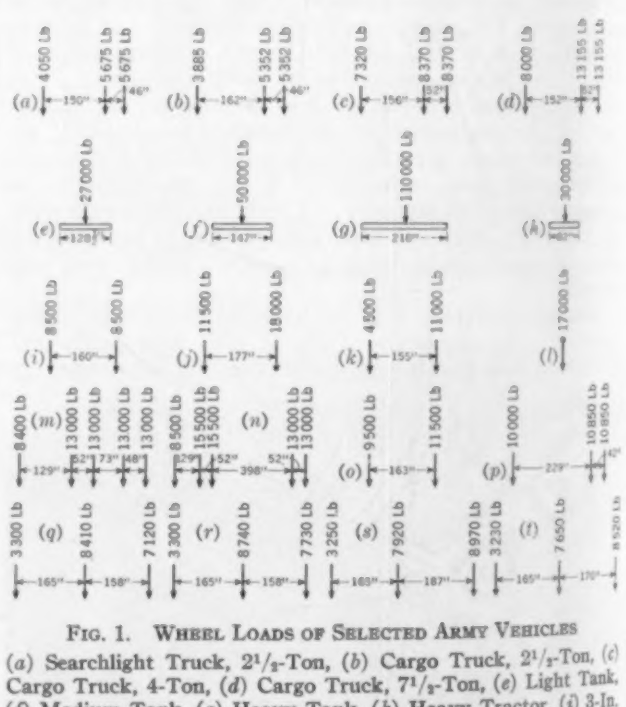


FIG. 1. WHEEL LOADS OF SELECTED ARMY VEHICLES

(a) Searchlight Truck, $2^1/_2$-Ton, (b) Cargo Truck, $2^1/_2$-Ton, (c) Cargo Truck, 4-Ton, (d) Cargo Truck, $7^1/_2$-Ton, (e) Light Tank, (f) Medium Tank, (g) Heavy Tank, (h) Heavy Tractor, (i) 3-In. Anti-Aircraft Gun Mount, (j) 155-Mm Gun Carriage, (k) 240-Mm. Howitzer Carriage, (l) 90-Mm Anti-Aircraft Gun Mount, Single Axle, (m) Fuel-Servicing Truck, (n) Wrecking Truck, (o) Balloon Winch, (p) Mobile Helium Purification Laboratory, (q) Operating Room, (r) Sterilizing Unit, (s) Kitchen, (t) Supply Trailer

be built, in whatever area, will be very similar to those built in France, and for usual conditions the same general designs, employing 4-post trestle or pile bents, will apply (Fig. 2). The standard-type trestle is designed for the heaviest loads accompanying a field army, or for the H-15 design loading adopted as standard by the American Association of State Highway Officials.

Standardization of design has of course been necessary in order to simplify the procurement, storing, and field requisitioning of bridge material, although the exigencies of the situation frequently will require variations from or adaptations of that design. When timber stringers are used, spans should not exceed 15 ft, center to center of trestles, and for spans up to 25 ft, steel beams are now available. Rarely will such spans be exceeded, because of the limitations imposed by the availability of material and the impracticability of transporting and handling heavy members.

Because of the relative simplicity of erection, framed trestle bents with mud sills are most frequently used, when suitable footings can be prepared. In soft ground, deep water, or where the scour is severe, piles of course have many advantages, and the engineer equipment includes gasoline shovels with pile-driving rigs employing drop-hammers. Air hammers would permit greater driving speed but require a comparatively bulky compressor plant. Pile bents in general correspond to trestle bents in dimensions, except that in bents up to 8 ft in height no cross bracing is required, and in all bents the two outer piles are "battered" to give stability. When conditions permit, the bearing power is determined by test loading or by observation of penetration under successive blows, but in general the probable safe loads are considered to be as given in Table I.

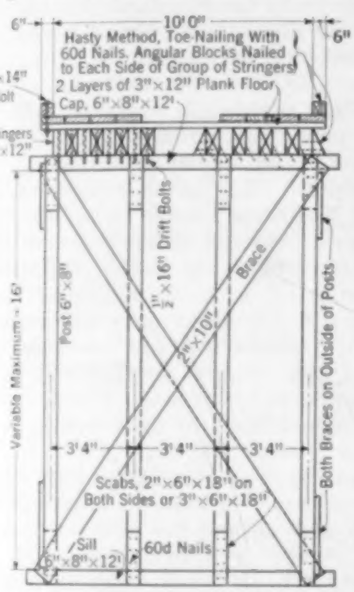


FIG. 2. BENT OF TRESTLE BRIDGE FOR CORPS AND ARMY LOADS (H-15)

A more humble and less symmetrical substitute, but one of great expediency in many situations and worthy of more consideration than it has received, is the crib, the value of which lies in its adaptability to irregular footings and its employment of easily available material. Railroad ties, dapped and drift-pinned together, are almost ideal for the purpose, as are odd pieces salvaged from wrecked buildings. The crib is filled with stone or rubble and the whole usually surmounted by a trestle bent.

TABLE I. BEARING POWER OF PILES, 1 FT IN DIAMETER, IN DIFFERENT SOILS AT VARIOUS PENETRATIONS

Character of Soil	Penetration, Ft	Probable Safe Load, Lb	Character of Soil	Penetration, Ft	Probable Safe Load, Lb
Soft mud	15	4,500	Compact sand	10	20,000
	30	10,000		12	24,000
Soft clay	10	7,000		15	28,000
Compact silt	15	10,000		20	36,000
	20	13,000		30	48,000
	30	20,000	Sand and gravel	8	20,000
Stiff clay	10	15,000		10	24,000
	15	23,000		12	28,000
	20	30,000		15	34,000
	30	45,000		20	43,000
Compact sand	8	16,000		30	60,000


Photograph by U.S. Army Engineer Board

PREFABRICATED STEEL PIER UNITS FOR PORTABLE H-20 BRIDGE

For unusual spans, or for speedier bridging in difficult locations, where intermediate supports are impracticable, the present equipment includes portable steel box girders. These, described in detail in the March 1941 issue of CIVIL ENGINEERING, are carried in sections approximately 12 ft long, and are available in two sizes. Using various numbers of girders, the smaller of the bridges, the H-10, may be used for spans about as follows:

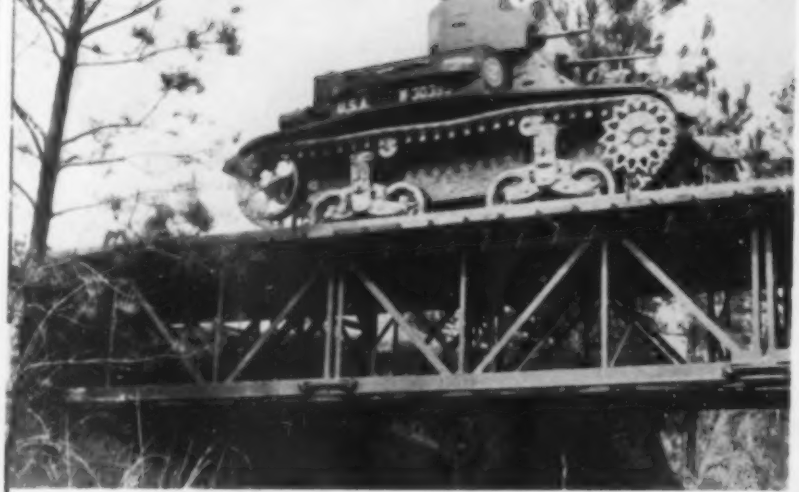
	H-10 Loading	H-20 Loading
2 girders	72 ft	36 ft
3 girders	96 ft	60 ft
4 girders	108 ft	72 ft

The H-20 bridge, using heavier sections, will carry the H-20 loading with two girders on spans up to 125 ft. It is apparent that, by using multiple girders and occasional intermediate crib or trestle supports, provision can be made for carrying even a 50-ton tank. In that connection it is of interest that the usual two-way civilian highway bridge of H-15 rating, because of the factor of safety employed and because of the distribution of the load, can carry such a tank (at a low speed), if the traffic is limited to one direction.

To be transported at the head of a mechanized column, particularly on cross-country movements, the engineers have developed trussed skids or ramps, each about 18 in. wide and 18 ft long, weighing about 600 lb and capable of carrying the 13-ton tank. These are useful for crossing narrow but deep streams, shell holes, or trenches, especially so where speed is vital, since they may be placed in a few moments. As an accessory development to expedite emergency bridging, there are


Photograph by U.S. Army Signal Corps

SPANNING A RAVINE WITH THE NEW H-10 PORTABLE—TANKS WAITING TO CROSS



Light Tank on H-10 Span—Note Bottom Chord Splice

available knockdown steel cubes, about 3 ft on a side, prefabricated from angles and quickly assembled on the job. These may be grouped and stacked to form piers as intermediate supports for the heavier bridges. For the temporary reinforcement of standing but deficient structures, such as exist on many of our highways, a simple jack-type shore similar to the building contractor's stud-jack, has a wide field of application. Such shores have been issued to engineer troops and used effectively during maneuvers.

Other types of portable truss bridges are under development, based on study of the best types in use by foreign armies, and the use of cableways as an alternative for bridges under certain conditions is also being studied. However, the status of this development work is at present confidential.

While the greater part of the bridging tasks confronting the engineers in war will call for partial or complete reconstruction, standing bridges will occasionally be available, and in peace-time maneuvers existing bridges will practically always be used. A new bridge should never be built if an existing one can be made to serve more quickly or easily.

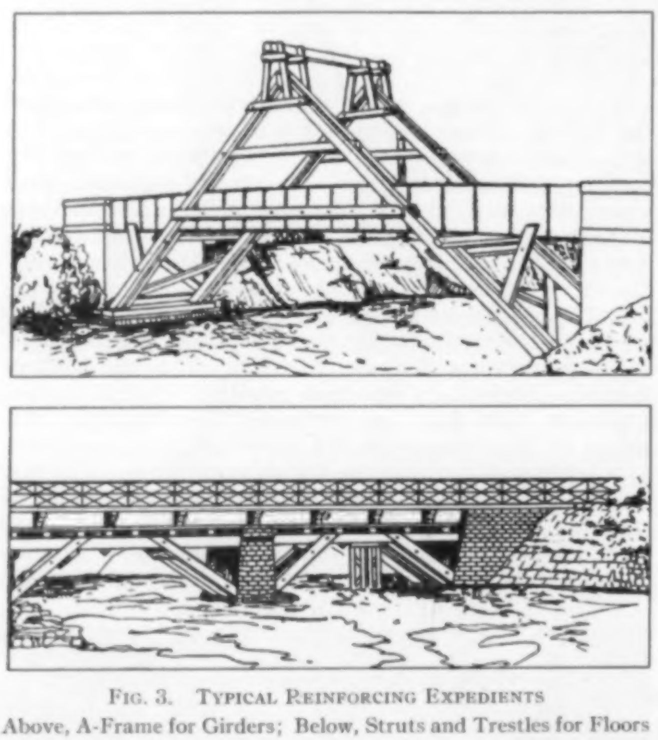


Fig. 3. Typical Reinforcing Expedients
Above, A-Frame for Girders; Below, Struts and Trestles for Floors

In this country the newer bridges on the principal interstate routes, such as those included in the "strategic highway network," and in fact those on the majority of the U.S. numbered routes and state highways, will in most cases carry gross loads of 15 tons, while the newer bridges on the secondary roads will usually be good for at least 10 tons. For such new bridges with heavy concrete or other type floors giving wide load distribution, single vehicles at low speeds may exceed posted loadings by 50% on single-lane bridges, or by 100% on wider structures.

For older bridges, or where there is any question of the condition or capacity, a careful examination must be made. A road and bridge reconnaissance is the first duty of engineer troops upon entering any area. In checking the capacity of a bridge, time will seldom be available for a complete study and calculation, and the military engineer must resort to a quick check, a few rules of thumb, and his own judgment, fortified by the fact that when there is any doubt a simple reinforcement can usually be quickly provided. One of the best criteria, of course, is the actual performance record of a bridge, which often may be determined by observation or inquiry.

Unless there is evidence to the contrary, it is assumed that the abutments and any intermediate supports are adequate or at least are what they appear to be. In the superstructure, a check of the horizontal and vertical alinement may indicate points of weakness. Record will be made of the spans, size, number and spacing of stringers, depth of steel beams, thickness of flooring, and condition of all members. As a simple rule, the thickness of the planking in inches should be at least $1\frac{1}{2}$ times the clear distance between stringers in feet, the minimum being 2 in., preferably 3 in. Inadequate flooring is easily reinforced with an additional layer. Stringers may be added to the deck, and truss members may be reinforced with timber struts or by cables and turnbuckles. Usually the simplest method will be to provide additional supports, using one or more trestle bents when footing is available, or knee braces or A-frames when the water is deep (Fig. 3).

Today we have greatly improved equipment and troops trained in its use; we have unlimited sources of material, and every day are tapping the vast reservoir of man power provided by the Organized Reserve and the Selective Service Act. The highway workers, miners, and construction men who come to the engineers do not need to learn so many new arts as do men who join the infantry and artillery. The methods of military road and bridge work do not differ basically from everyday civilian methods, except that they have the advantage of ample manpower and are governed by considerations of time rather than cost.

Our new engineer soldiers in many cases will be practicing their own skilled trades, reinforced by the army's training in organization and teamwork. With our combination of men, tools, and energy, we can face our bridging problems in the confidence that we shall be able to meet them effectively.

Portable Steel Ramp Is Handy for Ditches

Lake Traverse–Bois de Sioux Project

Flood Control and Conservation Are Objectives of Current Work on Minnesota–Dakota Border

By J. W. Moreland

Major, Corps of Engineers; District Engineer, St. Paul, Minn.

Flowing north into Hudson Bay, the Red River and its upper tributaries form the boundary between Minnesota on the east and the two Dakotas on the west. In this locality the current Lake Traverse–Bois de Sioux Project, 50 miles long, serves these three states, primarily in flood protection, and secondarily in the interest of recreation and conservation. Both hydraulic studies and construction features, especially for earth embankments, are covered in this interesting account by Maj. Moreland.

As its name indicates, the Lake Traverse and Bois de Sioux River Flood Control and Water Conservation Project is designed to serve more than one need. Its main purpose is to provide complete protection for 42,000 acres of agricultural land against a flood that may be expected to occur on the average once in every 30 years and to provide partial protection to these same lands and to 12,000 additional acres against greater but less frequent floods. A secondary benefit is the improvement in water levels of Lake Traverse (Fig. 1), which is separated into two parts of unequal elevation by Reservation Highway. Between Browns Valley, Minn., and State Highway No. 117 (Reservation Highway), this lake will be raised approximately 5 ft above its level of recent years, thus providing an ideal spot for boating, swimming, fishing, and wild life conservation. The lower part of the lake, which is directly north of State Highway 117, may be raised about 3 ft, greatly enhancing its possibilities for duck breeding and hunting.

Construction features of the project, based on their physical location and starting at the north end (Fig. 1), are readily divided into four parts: Bois de Sioux Channel Improvement, White Rock Dam, Reservation Highway Dam, and Browns Valley Dike.

Channel improvement work consists of enlarging and straightening about 24 miles of the Bois de Sioux River so that it can carry, with 1-ft freeboard, a discharge at White Rock Dam of 1,100 cu ft per sec. To accommodate the discharge from the Rabbit River, the channel capacity below was increased to 2,000 cu ft per sec. In some places it was advantageous economically, as well as hydraulically, to construct cutoffs, thus both straightening and shortening the river channel.

It was necessary to rebuild one railroad and two highway bridges and to alter two other railroad bridges. Because the five remaining highway bridges had closely spaced piers on shallow foundations, the channel section was modified at these points to conform to this condition and the banks where the constrictions occur were revetted with riprap to compensate for the increased velocity of flow.

The White Rock Dam, of impermeable rolled earth fill, is about 3 miles long, with a top width of 26 ft and a maximum height of 16 ft, allowing 4 ft of freeboard. Slopes are 1 on $2^1/_2$ upstream and 1 on 2 downstream. The upstream slope is protected by a 6-in. bed of gravel upon which is laid 12 in. of riprap. A toe drain, 6 in. of gravel between two 6-in. layers of sand, is incorporated in the downstream portion of the dam.

Its control structure consists of a highway bridge beneath which are three welded Tainter gates, 16 ft high and 13 ft wide. In general, the Tainter gates in dams are installed with the supports on the downstream side. In this case the reverse is true; thus the steel in the gate arms is in tension and the concrete in the supports is in compression, which of course is the desired condition. This method of installation is made possible because the pool usually will be held at an elevation lower than the trunnions and the gates need be operated infrequently during the freeze-up period.

Next to the south is the Reservation Highway Dam, which consists of the raised portion of Minnesota State Highway No. 117 where it crosses the lake bed. A control structure just below the bridge on this highway is 113 ft long, and consists of an earth-fill dam with steel sheet piling cutoff walls and grouted riprap surface. This is topped by a concrete sill through which passes a series of vertical H-sections, providing 17 short bays which may be partially blocked with stop logs. The elevation of the concrete sill is 974 ft, and the stop logs between the H-sections are provided to maintain a water surface at El. 977. In addition, two 18-in. culverts, controlled by gates, were placed through the dam with inverts at El. 970.0. (All elevations for this project are referred to Mean Sea Level Datum, U.S.G.S., 4th General Adjustment, 1912.)

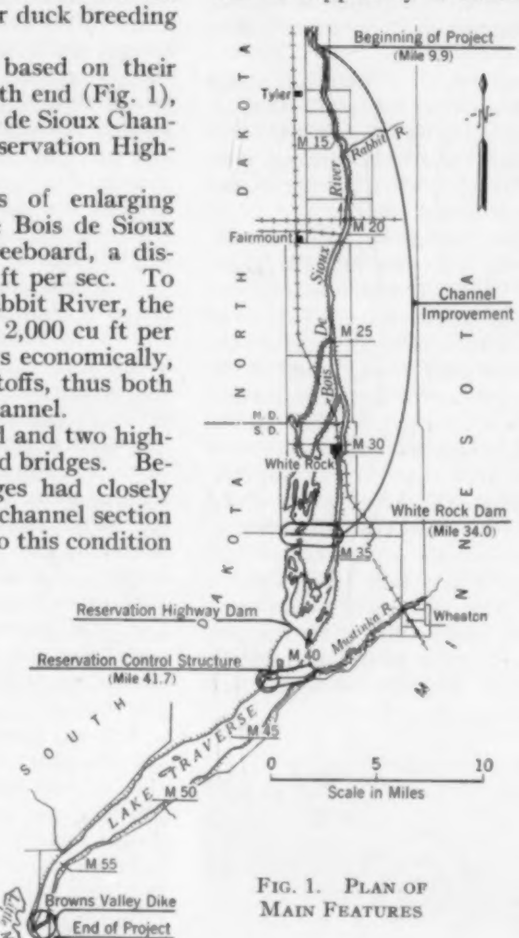


Fig. 1. Plan of Main Features

On the Minnesota side the highway, which is now being surfaced with soil cement, has been raised to El. 980, and on the South Dakota side, to El. 983 (Fig. 2). Under all possible flood conditions the South Dakota side will be out of water and the control structure will be accessible.

Further south, that is upstream, is the Browns Valley dike—to prevent the pooled water in Lake Traverse from overflowing across the divide southward into the Minnesota

River basin. It has only one main feature, an embankment 3,700 ft long extending northeast and southwest. Its maximum height is 10 ft and its top width is also 10 ft. Minor raising of two highways will be needed where the dike abuts against them at each end. Ditches will be provided to drain the area between the highways and south of the dike. This area now drains north into Lake Traverse and its drainage must be diverted southward by means of the Little Minnesota River.

HYDROLOGICAL STUDIES

Lack of records complicated the hydraulic design of the Lake Traverse–Bois de Sioux Project. In determining the conservation pool level, the normal inflow into the lake had to be first computed. It was found that there were intermittent discharge records since 1920 for the Mustinka River, the main tributary to Lake Traverse. For the missing periods, runoff was computed from rainfall records. As a check, the runoff for some periods of known discharge was computed, and a reasonable agreement was found. The discharge figures for the Mustinka River, which drains an area of 776 sq miles, were then increased in direct proportion to the Lake Traverse drainage area, 1,320 sq miles. Thus the monthly inflow since 1920 was determined.

Except at widely separated times, there was no record of lake levels. Monthly levels were found by means of the computed inflow, the outflow record at a Fairmount, N.D., station on the Bois de Sioux River, and a series of evaporation curves based on the mean monthly temperature, average monthly humidity and wind velocity. Reasonable checks were made with the available record, including the level that obtained in November 1936, which was 966.9 ft.

A second set of computations was then made assuming that all the water had been stored in the lake; that is, the outflow records at Fairmount were omitted. Because of large evaporation losses, natural conditions were little improved, the computed level of 966.9 being reached in January 1937 instead of November 1936.

To reduce evaporation losses, a reservoir with less surface area was needed. The lake is divided into two parts by Minnesota State Highway No. 117, which crosses the valley on an embankment and a short bridge. A dam at the bridge opening, together with the highway embankment would control the southern and deepest part of the lake. This southern section has about half the surface area, and almost all the drainage area of the lake. Computations for the south part, made as indicated previously for the entire lake, indicated that the normal conservation level could be taken at El. 977 (Fig. 2), which represents a compromise between flood control and conservation uses. The computations also showed that since 1920 the conservation pool would have reached this elevation in six different years. The elevation would have been 970.5 in January 1937, at which time, after the protracted drought, the lake would have been 3.6 ft higher than under natural conditions. It is to be noted that the elevation of 977 cannot always be achieved.

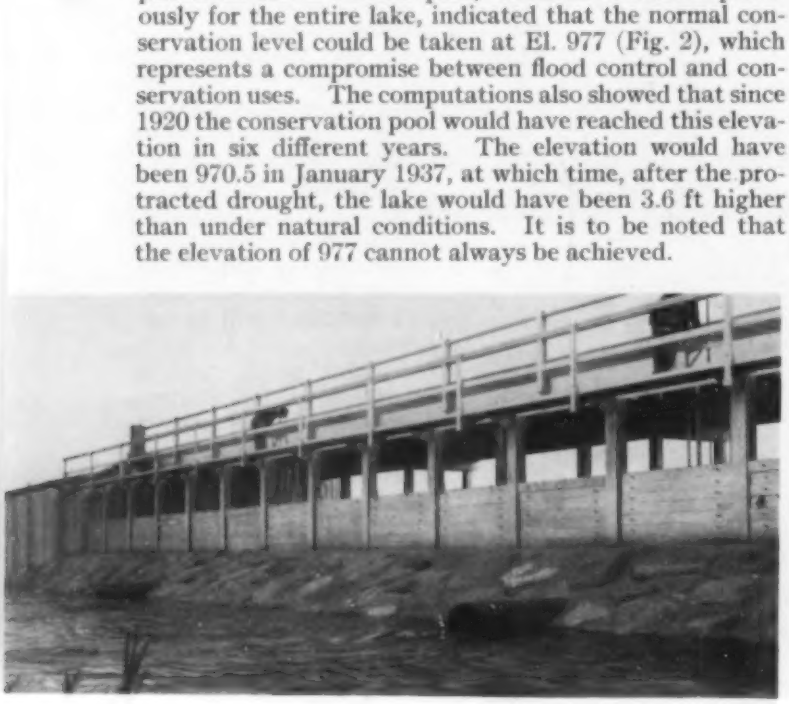
DISK HARROW USED IN SCARIFYING AND MIXING WATER WITH FILL ON WHITE ROCK DAM

Because there has been no flood discharge of appreciable size in the Bois de Sioux River since 1916, it was difficult to obtain data for flood control design. From a study of the discharge records of the Red River, of which the Bois de Sioux is a tributary, at Fargo, N.D., it was estimated that the frequency of the 1916 flood was on the average about once in 30 years. Studies indicated that protection against greater floods resulted in a large increase in cost and a small increase in benefits. It was then decided to design the flood control reservoir, outlet, and outlet channel so as to control floods equal to that of 1916.

Because inflow records into Lake Traverse during 1916 were not available, discharge records during that period for the Wild Rice River at Twin Valley, Minn., 100 miles to the north, were used. The two drainage areas are not unlike and the figures for the Twin Valley station were increased proportionally for a drainage area the size of that of Lake Traverse. From these data a summation hydrograph based on mean monthly discharges was prepared, and the discharges advanced 10 days for March, April, and May to account for the difference in time of the spring runoff. A check with the runoff for Lake Traverse for the spring of 1916, made from the rainfall records, showed close agreement.

Since the Bois de Sioux River flows northward and the runoff of snow melt in the headwaters may be blocked by ice in the lower valley, the reservoir should retain all inflow until May 1. This will allow sufficient time for the uncontrolled downstream tributaries to pass their probable peak discharges; also the period of possible ice jams, with resultant backwater flooding, will be over. From the summation hydrograph it was found that the volume to be stored up to May 1 would be 126,000 acre-ft. After that date it varied according to the rate of emptying the reservoir, which in turn determined the amount of channel improvements necessary to pass the outflow without flooding adjacent agricultural lands. Cost studies were made for three combinations of storage reservoirs and channel improvements, in which the flow capacities of the channel were 500, 800, and 1,100 cu ft per sec.

For any one combination, the cost was influenced by the necessary height of dam to store all water retained, the accompanying flowage and changes in highways affected, and an excavated channel downstream from the dam to carry the regulated flow with a water surface 1 ft below top of bank. Thus it was found that a regulated outflow of 1,100 cu ft per sec was the most economical, requiring a storage capacity of 126,000 acre-ft, which is available between Els. 981.0 and 977.0 south of the Reservation Highway and between Els. 981.0 and 972.0 north of that highway (Fig. 2).



LAKE TRAVERSE RESERVATION CONTROL STRUCTURE
Stop Logs in Place; Discharge Through Culverts

Bois de Sioux Channel After Excavation, Looking Downstream

So far the hydraulic study has been considered only on the basis of the 1916 flood. While the project is not designed to give complete protection for floods greater than that, the structures must be safe for any flood. All available rainfall information was studied, and from this it was estimated that the maximum possible inflow into the reservoir would be about 6,000 cu ft per sec. It was found that by allowing a surcharge of 1.0 ft on the normal flood-control elevation, an outflow of 4,000 cu ft per sec would be the maximum necessary for this inflow. An outflow greater than 4,000 could not of course be held within the banks of the Bois de Sioux channel, but flood conditions would still be alleviated.

DESIGN OF BOIS DE SIOUX CHANNEL

Many of the conclusions reached in these studies are shown graphically in Fig. 2. The slope and cross section of the Bois de Sioux channel were determined by a study of the ground slope. From the profile an average ground slope line was drawn from the dam to Rabbit River and thence to the end of the project. It was decided to make the bottom of the channel approximately parallel to this line (Fig. 2). A 1-ft freeboard was selected. After a study of the best cross section, a bottom width of 60 ft and side slope of 1 on 3 appeared the most economical from the standpoint of construction and maintenance.

To pass the maximum required outflow of 4,000 cu ft per sec, the White Rock control structure was designed so that its three Tainter gates can discharge 5,600 cu ft per sec with pool elevation at 982 and tailwater at 978. Thus, if necessary, only two gates can handle practically the entire discharge. In discharging 1,100 cu ft per sec under normal flood operation, the tailwater at the dam will be at El. 971 with a depth of 8 ft in the channel.

For the Reservation Highway structure it was first proposed to use a fixed dam with a crest at El. 977. However, as most of the inflow into Lake Traverse occurs upstream of this dam, it was found advisable to lower the sill to El. 974 and use 3 ft of stop-logs so that, when flood conditions become apparent, the upper pool can be discharged into the lower pool before El. 977 is reached in the upper pool. If the discharge is not begun until after the upper pool reaches this elevation, in a major flood the lower pool cannot be raised rapidly enough to prevent the highway from being overtopped while several feet of head exists between the two pools. This would very probably result in damage to the highway embankment.

With the upper pool at conservation level and the lower pool at or below El. 974, the structure can pass 1,700 cu ft per sec. When the Minnesota side of the road is overtopped, the discharge of 4,000 cu ft per sec at the White Rock Dam and the maximum possible inflow limit the discharge across this two-mile section of the Reservation Highway Dam to about 5,000 cu ft per sec.

Tests of the earth fill for the White Rock Dam made at the U.S. Waterways Experiment Station, which is operated by the Corps of Engineers at Vicksburg, Miss., indicated that upstream side slopes of 1 on $2^1/_2$, if revetted, and downstream side slopes of 1 on 2, were adequate. A top width of 26 ft provided adequate safety. When rock for revetting proved scarce, a study was made of the cost of an unrevetted upstream face with a slope of 1 on 15. This was found to be more expensive than the design first considered.

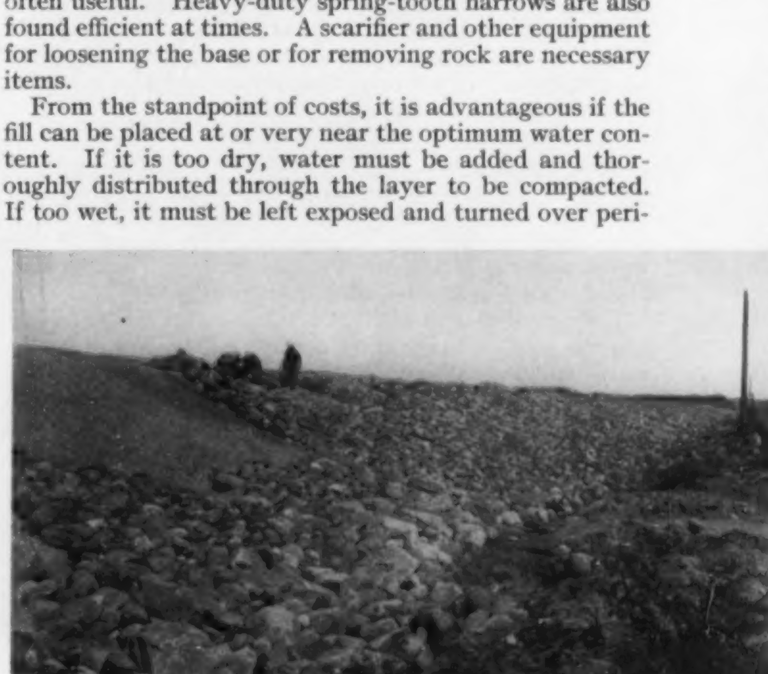
At the Reservation Highway Dam, which will be overtopped by some floods, the upstream and downstream slopes were made 1 on 8 without riprap. Inasmuch as possible failure of this earth structure is safeguarded by the White Rock Dam downstream, these slopes are believed adequate. They will be seeded to minimize erosion when overflow occurs, and it is believed that the maximum head will not exceed 1 ft. The available fill material in the vicinity of the Browns Valley dike is inferior to that found at the White Rock Dam; therefore, its landward slope and its lakeward slope above El. 981 were made 1 on 4. Because of the scarcity of riprap, the lakeward slope below 981 was flattened to 1 on 15.

ROLLED EARTH FILL FOR WHITE ROCK DAM

The most interesting part of the entire job was the compaction and moisture control of the impervious rolled earth fill. In all such work, careful consideration should be given to the selection of sheepsfoot tampers that are adapted to the available soil, and of supplementary equipment that assists in adding water to the soil or drying it.

In general, best results on heavy, cohesive soils will be secured with comparatively heavy types of sheepsfoot rollers. A unit load of not less than 200 lb per sq in. should be a minimum. Heavier rollers are justified on many kinds of work. If the feet are too close together or of such shape as to cause adherence of soil, and are used in the more plastic materials that are near the optimum moisture content, the rollers plug up completely with soil and cannot be moved. Experience indicated that cleaners should be provided both ahead of and behind the roller, and that these should point downward so as to peel the soil off the drum. Both the cleaners and the tamping feet should be kept built up to size by field welding. Heavy disks for mixing the soil and breaking up clods are often useful. Heavy-duty spring-tooth harrows are also found efficient at times. A scarifier and other equipment for loosening the base or for removing rock are necessary items.

From the standpoint of costs, it is advantageous if the fill can be placed at or very near the optimum water content. If it is too dry, water must be added and thoroughly distributed through the layer to be compacted. If too wet, it must be left exposed and turned over peri-



Gravel and Riprap on Upstream Slope of White Rock Dam

COMPLETED TAINTER GATE STRUCTURE FOR WHITE ROCK DAM FROM UPSTREAM

odically to cause uniform drying. The addition of water to material that is considerably below the optimum is most difficult, as dry soil requires considerable mixing to secure uniform absorption. Borrow pits in which the soil is at or slightly above the optimum are very desirable. Ponding of borrow areas to add water is an excellent construction procedure, if it is adapted to the excavating machinery used and if the soil is not too heavy to permit penetration of water. Very dense clay soils ordinarily cannot be improved by this practice.

The soils used in the White Rock and Reservation Highway dams varied from very fine silts containing appreciable percentages of clay, to rock flour of the weathered gray clay drift of the area. With the poorer silty soils, densities in the embankment varying from 95 to approximately 106 lb per cu ft dry weight were obtained with optimum moisture from 20 to 25%, and for the better grade of silty soil, a density of about 110 lb was secured with about 17 to 20% optimum moisture. The weathered clay drift which is the bed soil of the area could be compacted to dry-weight densities of 115 to 125 lb, depending upon the nature of the particular soil, with optimum moisture content of 13 to 16%.

Construction procedure was as follows. The previous lift of the embankment was wet down if it had dried below the optimum moisture. If the fill was too smooth it was scarified. Material was then placed in such thickness as to produce a final compacted layer of approximately 6 in., processed to insure the optimum water content, and then rolled by sheepsfoot tampers, 8 to 10 passes being required as a general rule over the entire area. At times the contractor ordered additional passes to compensate for soil drier than the optimum or to secure the mixing and drying effect produced by the tampers during the first few passes. In general, beyond a certain minimum number of trips, additional passes produce comparatively little improvement in density. Control of the water content is the most important factor, as without it no added amount of rolling can secure as good results as can be got with proper control of water and a smaller amount of rolling.

Specifications required development of a pressure of not less than 200 lb per sq in. of tamper surface, and rolling at the optimum moisture content to a density approaching the maximum. Samples were taken in borrow areas from each different type of soil encountered. Tests were then run on each specimen to provide data for the drawing of Proctor compaction curves.

Information as to the natural water content of the soil in the borrow areas, the optimum moisture content required for wet compaction, and the approximate amount of moisture that must be added, was furnished daily by the laboratory to the inspectors to guide their judgment. Inspectors were trained in the laboratory and in the field by working with experienced men. They developed a sixth sense which assisted them in determining whether or not the water content was near the optimum. They soon learned to determine the "feel" of the soil at and on both sides of optimum moisture content; to observe the behavior of the sheepsfoot tampers at different moisture contents with different types of soil; and in general to determine the quality of workmanship by sight and touch.

For each 1,000 to 1,500 cu yd of soil placed, check samples were taken by the laboratory personnel and tested. These specimens, $^1/_{10}$-cu ft in size, were taken at fixed elevations and fixed locations in the cross section at alternate even stations along the dike. Control tests were run from these field specimens taken after compaction to secure correlation between the density that should have been obtained and that actually achieved in the field. This information was given to inspectors daily, or as soon as available, to guide them in future work. The specifications required densities of 93% of the maximum, as determined by laboratory tests. The net results of all comparison tests show that densities have run as good as, or better than, specified.

OPERATION PROCEDURE

Operation of the two control structures, as planned, will limit the lower pool elevation to 972 during the winter. About March 1 the gates of the White Rock Dam will be closed and the inflow retained in the reservoir until May 1. After that date flows will be discharged not exceeding 1,100 cu ft per sec until the lower pool has been drawn down to El. 972, which will be maintained as far as possible. If the pools tend to exceed El. 981 before May 1, the Tainter gates will be opened and flows up to 4,000 cu ft per sec will be permitted in an effort to maintain the pool at El. 981. At all times the water level in the upper pool will be kept at El. 977 as far as possible. As soon as the level tends to rise above this point, flow will be discharged into the lower flood control pool. Stop logs may be removed to expedite discharge.

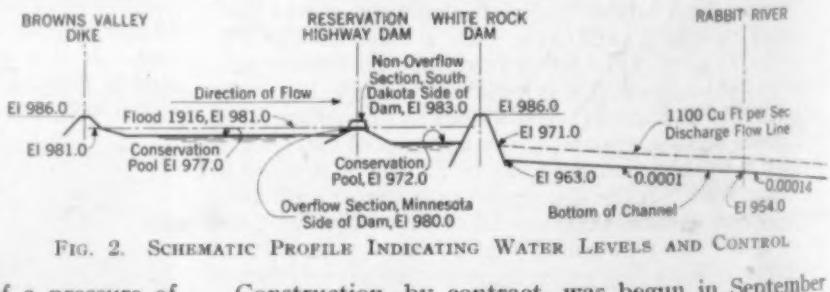


FIG. 2. SCHEMATIC PROFILE INDICATING WATER LEVELS AND CONTROL

Construction, by contract, was begun in September 1939 and will be completed during 1941. The project was designed and construction inspected by personnel of the St. Paul District Office, U.S. Engineers, under the direction of the writer and his predecessor, Brig. Gen. Philip B. Fleming.

Construction Features of Shasta Project

Part II. Conveying Aggregate, Mixing and Placing Concrete

By Ralph Lowry, M. Am. Soc. C.E.

Construction Engineer, U.S. Bureau of Reclamation, Redding, Calif.

In addition to mere size, this project is outstanding because of the details and thought that were put into the contractors' plant. The cableways are of record-breaking size and are so arranged that all parts of the dam and power house can be worked on from above at all times. The aggregate conveyors are of unprecedented length. The shops are equipped to make major repairs of all kinds. The hospital is prepared to take care of any emergency. The hospital, office buildings, and bunk houses are heated with butane in winter and are air conditioned in summer. Even the smallest camp house has an electric stove and electric hot water heater. Many of these refinements, suggesting the efficiency of the line production of automobiles, are described in this interesting article by Mr. Lowry, which supplements his paper in the preceding issue.

Planning a structure as huge as Shasta Dam, requiring 10 million tons of concrete aggregate, to say nothing of other supplies, is a major task in itself. To meet the strict specifications and obtain the required volume, it was necessary to go to a river deposit 10 miles to the south, at Redding, Calif. There a large aggregate plant was installed for procuring the sand and gravel, as described in the June issue.

Next came the question of transportation to the dam site. The obvious solution was by rail, since the main line of the Southern Pacific ran between the supply at Redding and the terminus at Coram, just below the dam. Further study, however, showed the economy of continuously moving the tremendous quantities of aggregate by belt conveyor. Accordingly the contractor was authorized to install an elaborate conveyor system. The Redding–Coram conveyor is $9\frac{1}{2}$ miles long. It consists of 26 flights of varying lengths, depending on the grade. The longest flight is $\frac{2}{3}$ of a mile, and the steepest grades are 25%. Each flight is powered with a 200-hp motor. The motors on the downhill flight act as generators by utilizing the available potential energy, and are braked automatically in case of power failure. The speed is 550 ft per min or approximately 6 miles per hr. The belt width is 36 in., and the capacity is 1,100 tons per hr. Since it would take a train about two hours to make the round trip to the dam without allowing any time for loading, switching, or dumping, this conveyor has the approximate capacity of a 44-car train in continuous operation. The aggregate is weighed for payment over belt scales as it is delivered at Coram, where it is dumped into concrete-lined boots by a shuttle belt. All flights are remotely controlled from the Coram end of the conveyor. In starting the belt, the flight nearest Coram, No. 26, is first put into operation, and just as soon as this flight attains full speed, No. 25 is automatically started, and the same sequence prevails until all flights are in operation. In stopping the belt, the sequence is reversed. Any flight may be stopped at its particular station, in which case all flights between the station and the plant are likewise automatically stopped.

The belt conveyor has been operated with entire satisfaction to date. One difficulty was encountered when downgrade flights operating in the rain continued to travel over the stationary head pulley when the motor was stopped. This condition was corrected by installing a corrugated rubber cover around the surface of the head pulley. Some difficulty was also experienced with excessive breakage of the larger sized aggregate in the drop of the material from one flight to another. Baffles installed in the near vertical chutes between the flights have largely corrected this undesirable condition. The Government pays the Columbia Construction Company 60 cents a ton for aggregate, 40 cents for processing, and 20 cents for delivery at Coram. This price per ton is equivalent to $1.10 for the aggregate in a cubic yard of mass concrete. The gravel processing plant cost $1,400,000 and the belt conveyor between the plant and Coram $1,460,000.

The contractor constructing the dam, the Pacific Constructors, Inc., operates the shuttle belt dumping the proper sized aggregate in its respective 1,000-ton-capacity boot from which it is reclaimed by a belt conveyor running underneath the boots and transporting the aggregates, first one then another, to the individual storage stock piles located between Coram and the dam, which is about one mile north. The 5 stock piles are in line and vary in capacity from 25,000 to 40,000 tons, being built up by the aggregate deposited on both sides of a steel trestle by the use of a small aeroplane tripper. The coarser sized aggregates are delivered onto rock ladders to prevent excessive breakage.

The material from the storage stock piles is likewise reclaimed and transported to the mixing plant at the dam by belt conveyor operating through a tunnel underneath the piles. The aggregate is dumped onto the belt through electrically operated gates located at the top of the tunnel. The belt conveyor system between Coram

Aerial View of Dam Site Looking North up Sacramento River

Southern Pacific Railroad Tunnel in Left Foreground Next to Power House Construction; Cableway Headtower and Automatic Concrete Mixer Plant at Left Center; a Cableway Tailtower on Circular Track at Lower Right

(LEFT) CONCRETE BUCKET DISCHARGING 8 CU YD
Dump Line Opens and Closes Bucket

(RIGHT) CONCRETE TRANSPORT CAR, WHICH HAS RECEIVED BATCH DIRECTLY UNDER MIXER PLANT, DELIVERS IT INTO 8-CU YD BUCKET AT CABLEWAY DOCK

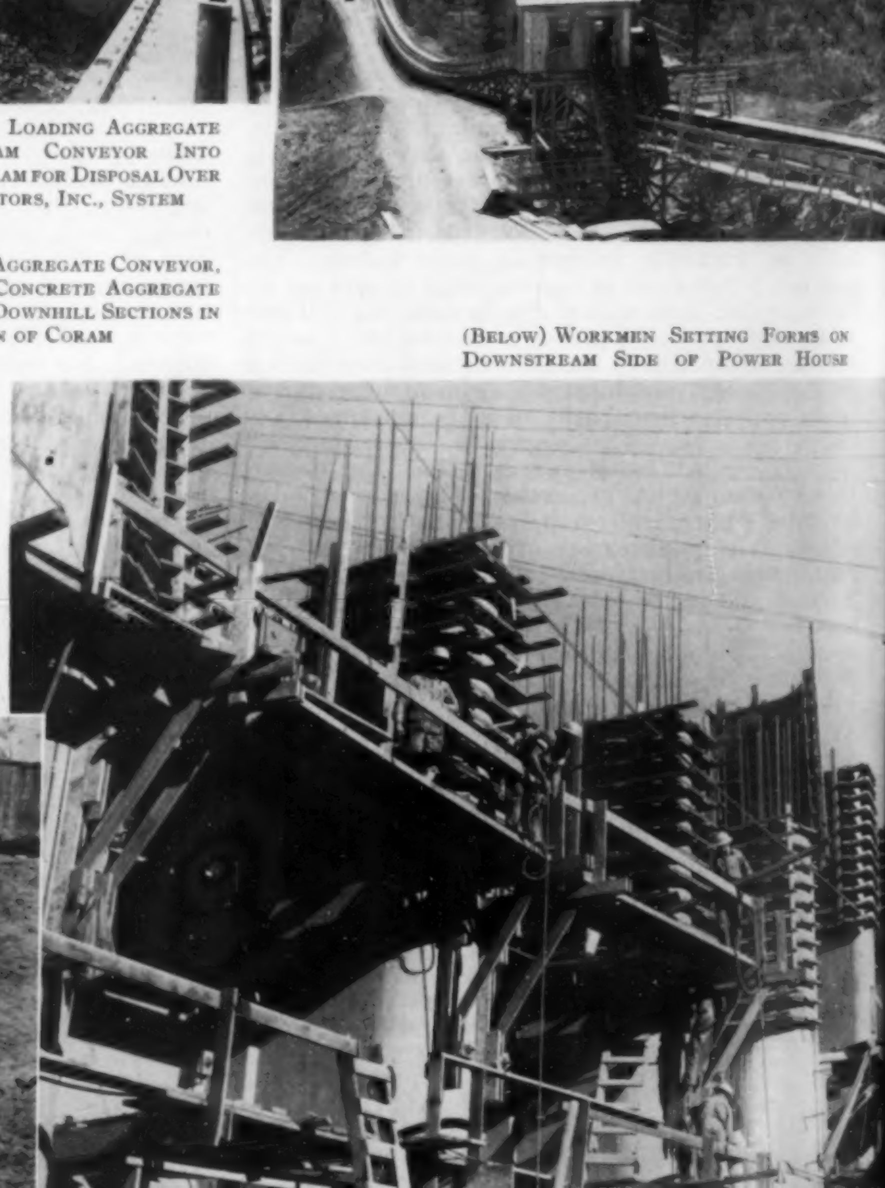
Car, Powered by Third-Rail System, Carries Two 8-Yd Batches Which Can Be Quickly Spotted Over Bucket

SHUTTLE CONVEYOR LOADING AGGREGATE FROM REDDING-CORAM CONVEYOR INTO TRACK HOPPER AT CORAM FOR DISPOSAL OVER PACIFIC CONSTRUCTORS, INC., SYSTEM

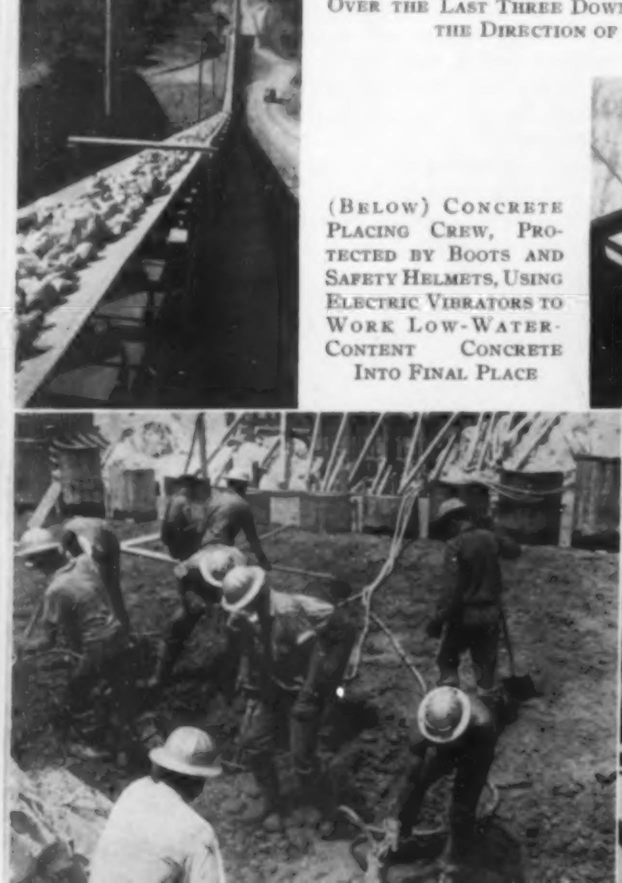
(BELOW) REDDING-CORAM AGGREGATE CONVEYOR SHOWING TYPICAL BELT INSTALLATION WITH FLIGHT TRANSFERS AND MOTOR HOUSE

(LEFT) REDDING-CORAM AGGREGATE CONVEYOR, SHOWING DELIVERY OF CONCRETE AGGREGATE OVER THE LAST THREE DOWNHILL SECTIONS IN THE DIRECTION OF CORAM

(BELOW) WORKMEN SETTING FORMS ON DOWNSTREAM SIDE OF POWER HOUSE



(BELOW) CONCRETE PLACING CREW, PROTECTED BY BOOTS AND SAFETY HELMETS, USING ELECTRIC VIBRATORS TO WORK LOW-WATER-CONTENT CONCRETE INTO FINAL PLACE



Southern Pacific News Bureau

Aerial View of Dam Site Looking North

Cement Silos and Aggregate Storage Bins at Lower Left with Covered Conveyor Belt Leading to Mixer Plant at Base of 460-Ft Cableway Headtower. Tailtowers on Circular Runways at Lower Right, near Shops, Office Buildings, Hospital, and Contractor's Camp

and the mixing plant is made up of 12 flights, having a 36-in. belt width and a capacity of 1,000 tons per hr when operated at its usual speed of 450 ft per min.

Low-heat cement for the dam is purchased under contract, and is delivered in bulk by rail to an unloading station a half mile south of the dam and adjacent to the storage stock piles. Individual cement cars are unloaded by one of two 125-hp cement unloading machines. Each of these machines is remotely controlled by one operator, and a crew of two men in addition to the operator can unload a 300-bbl car of cement in 40 min. The unloaded cement is conveyed pneumatically through an 8-in. pipe to one of the 10 storage silos located adjacent to the unloading station; these have a total capacity of 60,000 bbl. A pneumatic displacement pump located at the silos receives its supply from the bottom of the silos and forces highly aerated cement to the mixing plant through a 10-in. steel pipe. Under normal operating conditions, the pump will deliver 450 bbl of cement per hour to the plant, using 2,500 cu ft of free air per minute at 80-lb pressure.

At the mixing plant, cement is stored in two bins, each having a capacity of 1,600 bbl, located in the top of the plant and surrounded concentrically by the five 600-ton-capacity aggregate bins.

The concrete mixing and batching plant is very compact, and is located midway up the right abutment just upstream from the dam and at the base of the cableway headtower. This plant consists of automatic and recording weigh batchers for each aggregate, cement, and water; and five 4-yd mixers set concentrically about a steel concrete hopper. The weigh batchers discharge into a collecting cone and chute which can be rotated to the front of any mixer. Then, by protruding a retracted chute, sealed contact is made with the front of the mixer so that none of the batch is lost during charging. From one control panel, the batcher operator can select any one of six mixes and cause it to be batched and weighed automatically. Then by moving one lever forward he can dump the batch into any mixer selected by the operator controlling the mixers. The mixer operator controls the charging and discharging of any mixer as determined by orders from the dam. The majority of the controls in the plant are electrically controlled and air operated, which makes for a compact semi-automatic plant.

The autographic recorder has a number of electrically controlled pens which show to scale the weight of each material batched, also when it is dumped. The consistency curve for each mixer is also shown and by using a guide pen, the batcher operator can readily tell if a batch is too wet or too dry. The recorder roll travel is 3 ft per hr, or 0.6 in. per min, and is a check on the mixing time. The recorder paper is ruled and printed automatically each minute by a rubber stamp so that quantities of time can be scaled from it. At the end of each 24 hours, the roll is removed and becomes the property of the Government. It is used for determining the quantities of materials used and the concrete produced.

An extremely large percentage of the 6,000,000 cu yd of concrete placed in the dam will be mass concrete, using 6-in. maximum sized aggregate. The average slump of the mass concrete produced to date varies from $1^{3}/_{4}$ to $2^{1}/_{4}$ in., depending primarily upon weather conditions. All concrete mixes are designed for maximum feasible economy, after due consideration has been given to stress conditions, durability, workability, and other factors. It has been determined that a net water-cement ratio of 0.60 by weight will produce concrete meeting these requirements. The mass concrete mixes incorporating the 6-in. maximum aggregate have a cement to sand and gravel ratio of 1 to $9^{1}/_{2}$, and a gravel-sand ratio ranging from 2.75 to 2.95, depending on workability requirements. The proportioning of the four sizes of gravel in the mixes is varied to use the pit yield. These mixes produce one yard of concrete per barrel of cement and have an average 28-day strength of slightly less than 4,000 lb per sq in. All operations at the concrete mixing plant are rigidly controlled and inspected. Each shift, routine tests are made of aggregate grading, moisture and temperature, mixer efficiency, silt determination, and specific gravity. Test cylinders are cast

TAILTOWERS NOS. 1, 2, AND 3 ON LEFT SIDE IN CANYON
Electrically Operated from the Headtower on Other Side of Canyon. Note Heavy Counterweights in Rear and Inclined Front Trucks for Maintaining Balance

from each mix used each shift. These cylinders are standard cured and tested at 7, 28, and 90 days. Consistency determinations are made hourly by slumping samples taken at random from the concrete as it leaves the plant.

The concrete is placed in the dam by a system of seven cableways having a common structural steel headtower 460 ft high. The tailtowers are located to fit the ground in such a manner that complete cableway coverage of the dam and power house is obtained. The tailtowers are all free to move in the arc of a circle, the center of which is the headtower. The cableway spans vary from 700 ft for cableway No. 6 to 2,670 ft for cableways 1, 2, and 3. Each cableway is operated by an individual electrically powered 3-drum hoist, remotely controlled through a system of electrical relays by an operator who is stationed on a floor halfway up the tower. The operating machinery for each cableway is also located on this floor. One drum of the hoist is used for the endless cable which transports the load between head and tailtowers, the second drum for hoisting and lowering the load, and the third drum for the load line which is used for dumping and closing the concrete bucket.

Electric trains, with two 8-cu yd side-dump hoppers to each train, are used for transporting the concrete from the mixing plant to the loading dock over a track encircling the base of the headtower. At the dock either hopper is spotted over an 8-cu yd bucket hooked to the cableway rigging, and the hopper discharged by releasing an air-operated lock. The cableway then transports the loaded bucket to the point of placement.

The concrete in the dam is poured into blocks 50 ft square bounded by the transverse and the staggered longitudinal joints. The blocks are raised in 5-ft lifts, with a minimum of 72 hr between pours. The concrete pours are confined by metal-lined, wood-panel forms of the cantilever type, the forms being raised for each lift. The horizontal surface of each lift after pouring is roughly leveled with a gentle slope to the center where a temporary drain pipe is located. The panel forms are usually raised some 48 hr after the pour has been completed by means of aluminum A-frames equipped with manually operated chain hoists. Shortly before the next pour is to be made, the horizontal surface of the block is sandblasted, the cooling pipe placed, and the surface of concrete thoroughly cleaned by jets of air and water. A layer of grout consisting of sand, cement, and water in the same proportions as used in the concrete, is then spread uniformly over the surface of the preceding pour to a depth of 2 in., preparatory to placing the fresh concrete. The concrete is placed in horizontal layers 15 in. thick, or four layers to the 5-ft lift. Concrete is brought to the pour by one cableway, usually at the rate of 100 yd an hr, or a bucket every 4 min, requiring about 5 hr to complete a standard block. The concrete buckets used are of an original pattern designed by the contractor, and first used at Shasta Dam. The buckets are 6 ft square and 7 ft high. The bottom is in two halves, each hinged to opposite sides of the bucket, and the opening controlled through a device connected with the dump line in such a way that part of the load can be released and the bottom flaps again closed. With safety latches released, the weight of the concrete opens the flaps as the dump line is slacked off, and when the bucket is raised from a resting position in the pour. The bucket can be readily spotted to any desired location in the form; this is accomplished through a signalman stationed at the point of placement, who is in direct and constant communication by telephone with the cableway operator in the tower. The operator controls all movements of the cableway, including the movement, by remote control, of the tailtower along its circular track. The square bucket with full bottom opening permits the relatively dry concrete to be discharged quickly without sticking and without segregation. After being deposited in the form, it is readily worked into place with a crew of 9 men, consisting of a foreman, 2 laborers, and 6 men operating 3 two-man vibrators. The vibrators currently used are electrically powered with a frequency of 7,000. Initially the concrete vibrators were powered by a compressed air motor, but these have now been largely discarded by the contractor in favor of electrically operated machines.

The concrete plant is designed to place an average of 6,000 cu yd of concrete per 24-hr day. Under favorable conditions, and for some periods, this daily rate may be exceeded. The mixing plant, equipped with five 4-yd mixers, could probably produce 9,000 cu yd per day, and the gravel plant could no doubt process all the aggregates needed for the maximum capacity of the mixing and placing plants.

The first concrete in the dam was poured in July 1940, and to date some 1,000,000 cu yd have been placed—16% of the 6,000,000 total. The rate of placement to date has been considerably below the rated average, primarily because of excessive rainfall and the comparatively small number of blocks that have been started. This condition, however, is fast disappearing as additional foundation area is prepared and additional blocks started.

The work is programmed for completion of all mass concrete in the dam by the late fall of 1943. Shasta Dam is the key feature of the Kennett Division of the Central Valley Project. The project is being constructed by the Bureau of Reclamation under the general supervision of John C. Page, Commissioner; S. O. Harper, Chief Engineer; J. L. Savage, Chief Designing Engineer; and R. S. Calland, Acting Supervising Engineer, all members of the Society.

The concrete mixing and placing plant, the gravel processing plant, and the belt conveyor system were designed by members of the contractors' organizations, with the assistance of various consultants called in for that purpose.

Stable Equilibrium for Railway Cars

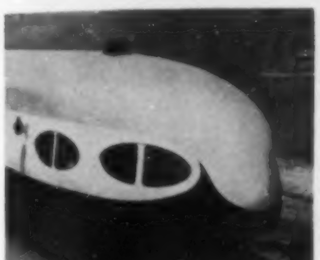
Passenger Equipment Designed with Stressed Skin and with Axis of Suspension Above Center of Gravity

By George E. Solnar, Jr., Jun. Am. Soc. C.E.

Project Engineer, Pacific Railway Equipment Company, Los Angeles, Calif.

Indian fighting and golden spikes marked one era of railroad evolution. After many years of quietly sawing wood, rail transportation, with its streamlined trains, enters another period of spectacular change. The developments presented here by Mr. Solnar embody a twofold advance over more familiar types of cars—the correction of body roll and the reduction of weight through full utilization of semi-monocoque principles in the design of the body shell. In addition, improvements in both vertical and lateral springing and in truck design greatly reduce all forms of shock. A secondary consequence of the wide use of such rolling stock should be a marked decrease in rail maintenance costs.

A railway car body must be placed upon its trucks so that its weight may be transferred through the trucks to the rails. At the same time, the car body must be isolated from these trucks to provide comfort for those riding within. Passenger comfort depends on many things, but a great source of discomfort is an excessive vibration transfer from the truck to the car body. Other sources of discomfort are jolts on rough track, and lateral lurches and body rolls on curved track.



Every railroad curve is designed for a limiting speed. If a car goes into a curve at the speed for which it was designed, there is no lurch or body roll. If, however, the car is traveling at a higher speed, it lurches as it starts into the curve, and then the centrifugal force acting on the car causes an uncomfortable roll of the car body toward the outside of the curve. The causes of these discomforts are basic in conventional car construction. Center-plate mounting does not provide a fundamentally stable condition, and equilibrium must be maintained through side bearings. Any attempt to cushion lateral shocks effectively, or to provide softer body springs, is complicated because the center-plate mounting is basically not adaptable to that treatment.

An attempt to combine the passenger comfort of heavy, slow-schedule trains with the speed of modern, light-weight trains has resulted in the development of a railway passenger car with a pendulum body suspension to replace the conventional truck and center-plate mounting. A desire to combine high strength and rigidity with minimum weight led to the adoption of a "stressed-skin" car-body structure.

Let us look at the cross section of a conventional car (Fig. 2). The center of gravity of the body is above the banking axis (center plate). Once the center of gravity is displaced by a lateral force, the weight of the car will augment the displacing movement of this lateral force. The truck springs, therefore, must be stiff enough to resist the moment of the lateral displacement force about the banking axis plus the moment of the body gravity force, or an excessive body roll will result.

With present equipment, any attempt to push trains to greater speeds must result in either decreased passenger comfort or expensive roadbed redesign and realinement. However, an investigation of passenger-car design from a functional point of view has shown that the problem can be solved by changes in equipment construction. A railway passenger car suspension can be developed to embody at once four fundamental objectives: (1) A basically stable suspension; (2) lateral springs soft enough to be an effective cushion for lateral loads; (3) vertical body springs with sufficient vertical deflection to isolate adequately the car body from annoying truck vibrations; and (4) a car body designed to take the loads imposed by the new suspension and yet be of light weight.

The pendulum suspension and stressed-skin body structure described here are the results of this study. The stable equilibrium is established by placing the banking axis, or center of rotation, above the center of gravity of the car body. This banking axis is established by lateral springs and positioning arms. The lateral springs cushion the lateral movements of the whole body. The action of the pendulum suspension is compared with the conventional system in Fig. 2. When the car body with stable pendulum suspension is subjected to displacement by a lateral force equal to that imposed on a conventional car, the body gravity force creates a restoring moment rather than a displacing moment. The uncomfortable body roll, caused by improper curve superelevation, is thus corrected, lateral lurches are softened by lateral springs, and softer vertical body springs, providing a more complete body isolation from truck vibrations, may be used without fear of excessive body roll.

Experimental test cars (Figs. 1 and 3) were constructed to prove the practicability of the pendulum suspension. These cars were made of wood and lacked certain items of standard equipment. But the testing program proved their success sufficiently to warrant the placing of contracts for steel cars of the new design. The construction and testing of the experimental cars has been described by P. K. Beemer, F. C. Lindvall, E. F. Stoner, and W. E. Van Dorn, in "A Fundamental Development in Suspension and Construction for Railroad Cars" (*Mechanical*

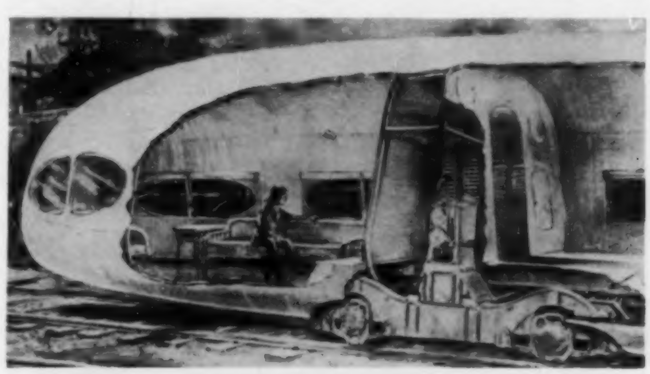


Fig. 1. Sketch of the Experimental Car and Suspension System

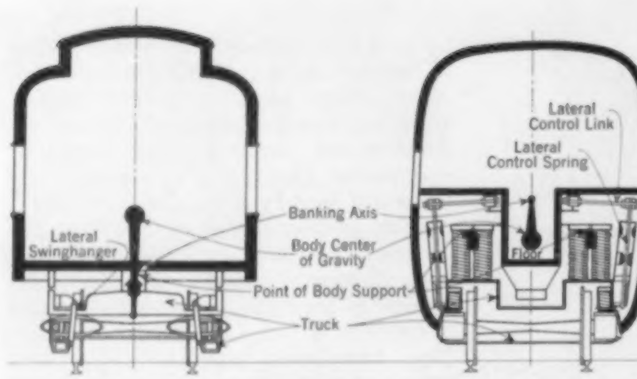


FIG. 2. COMPARATIVE CROSS SECTIONS
(Left) Conventional System, (Right) Pendulum Suspension

Engineering, November 1940) and in "New Pendulum-Type Cars Tested' (*Railway Age*, July 1938, page 294).

The location of the body springs and the lateral control springs is clearly distinguishable in Fig. 4, which shows a truck assembly of one of the experimental cars. The steel car truck is larger, but similar in design.

Figure 5 shows the new truck frame before the equipment has been installed. It is constructed of a number of hollow, high-tensile, low-alloy sections arc-welded together. Four coil body springs, instead of the two shown in Fig. 4, are to be located on the pedestals at each side of the frame. Lateral leaf springs are attached at their bases to the side of the body spring pedestals of the truck. The tops of the lateral springs are connected to the car body by positioning rods which determine the banking axis. The lower portion of the lateral springs are enclosed in a rigid housing containing spring stops. The stops control the length of the spring and thus provide lateral springs which are soft enough to absorb low-amplitude vibrations, but which become stiff enough to resist large lateral forces. A longitudinal tie, or thrust tube, provides the 250,000-lb horizontal connection between the truck transom and the car-body underframe, as specified by the Association of American Railroads. Vertical tie rods provide the 250,000-lb A.A.R. specification tie between the truck and the car body for extreme vertical movement. Vertical and lateral shock absorbers act with the springs between the truck and the car body.

Vertical loads are transmitted to the truck from the body through the main body springs. These loads are taken to the wheels through side members of the frame. The frames are designed to take vertical load either symmetrically or at diagonal corners, and are made up of a series of hollow sections having a high torsional rigidity.

Lateral loads through lateral springs and lateral spring housings induce bending in the transom, and torsion in side members. Lateral loads are taken out at the journal boxes, with the consequent introduction of torsion in the side members of the truck frame. Although an ultimate stress design method was used for the truck as well as for

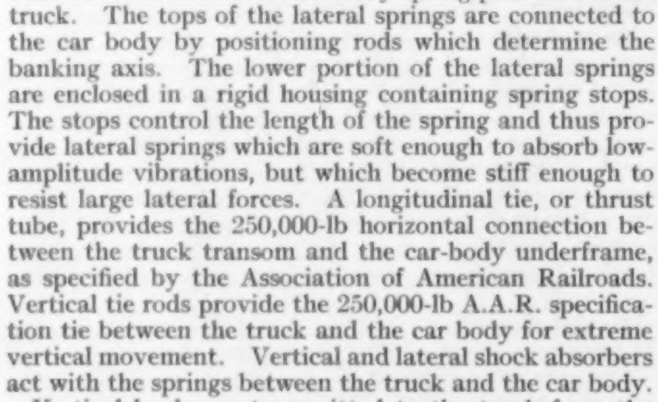


FIG. 3. EXPERIMENTAL CAR—BODY OF PLYWOOD

the car body, the design procedure was similar to that used in like structures.

Because of the pendulum suspension, the point of body support is above the floor level. The latera spring connection is also above the floor level. The vertical and lateral structure loads must be brought to these points of

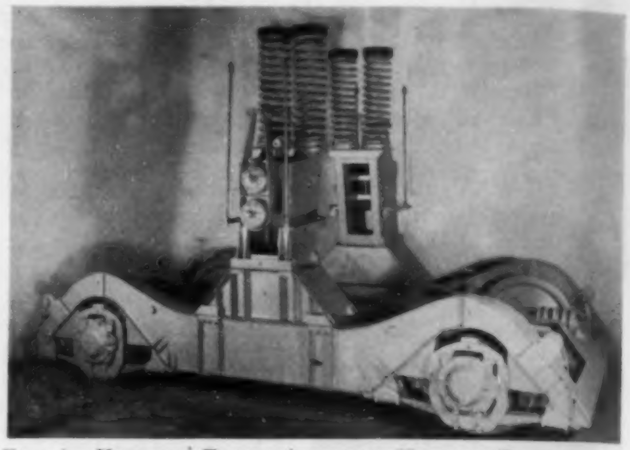


FIG. 4. VIEW OF TRUCK ASSEMBLY USED IN EXPERIMENTAL CAR—STIFFENERS WELDED

support. A light body structure is desirable because it reduces the train power requirements and simplifies the springing problem. It was therefore decided to take advantage of the high strength-weight ratio afforded by the stressed-skin, or semi-monocoque body structure. Such a structure, as the name implies, is a thin shell forming a closed tube. The shell must have sufficient stiffening members to make the enclosed thin panels effective for carrying load. A very simple analogy would be a thin-walled tube used as a beam. If the diameter of this tube is sufficiently large, the walls may be extremely thin and provide sufficient section to take the bending and shear loads. The portion of the thin cylinder wall in compression and shear is prevented from buckling by a system of rings and longitudinal stiffeners providing a very strong and rigid beam very light in weight.

ADVANTAGES OF STRESSED SKIN BODY CONSTRUCTION

Because of its functional adaptability, stressed-skin body construction has been widely adopted by the aircraft industry, where structure weight must be reduced to a minimum. This type of body structure was also very successful on the experimental cars because it was simple, strong, and inexpensive. Because of the redundancy of the structure, much time was spent in accurate stress analysis. The advantages of light weight could not be completely realized on the steel cars, however, because of car specifications governing the size of certain members regardless of their function.

The essential structural elements of the steel stressed-skin railway-passenger-car body are: (1) thin skin or sheathing; (2) longitudina' stiffening members; (3) transverse stiffening members, called carlines, at the roof, side posts at the sides, and floor beams, or cross bearers on the underframe; (4) structural bulkheads through which vertical and lateral loads are transferred to and from the body structure; and (5) miscellaneous structures, such as heavy end frames, essential for housing draft and buff gear; center sill, essential for heavy buff and draft loads; and the body spring supporting elements.

Both the longitudinal and the transverse stiffening members are light in weight and are rigidly fastened to, and act integrally with, the skin. The corrugated floor-

ing is a variation of a sheet with very closely spaced stiffeners. All these elements are interconnected to form an integrated unit. If one word were chosen to distinguish the stressed-skin body structure, it would be "continuity." This is true not merely because this characteristic is physically unique in a car body, but also because in this instance it is functionally essential.

In the interior of the structural shell (Fig. 6) there are several features which illustrate the functiontal importance of this continuity.

FIG. 5. TRUCK FOR STEEL CAR BEFORE ASSEMBLING

The longitudinal flooring, one of the most highly worked portions of the structure, is responsible for much of the over-all continuity of the design. Considered as a portion of the center-sill construction with the center sill and shear panels, the flooring must carry compression loads; in like manner, it is essential in distributing heavy concentrations of equipment and live load over several floor beams The flooring is also capable of transmitting about 40% of buff loads from the center construction to the sides of the car, and at the same time carries the live and dead load between the floor beams. The longitudinal stiffening members with their portion of effective skin, the flooring, and the center sill, form the strength of the car for bending and compression loads. Only a small portion of the skin, the effective skin, adjacent to these members is useful in carrying compression.

The support-structure bulkheads transfer uniformly the vertical and horizontal reactions of the truck to the sides and roof of the car. Continuous transverse rings are formed by virtue of the fact that the floor beams (Fig. 7) are rigidly fixed to the bottoms of the side posts of the side panel, and these side posts are rigidly tied to the carlines of the roof panel. This complete ring around the car is capable of transferring the load on the floor beam to the side sheet, and of withstanding the accompanying thrust, moment, and shear at all points. These rings are designed to prevent spreading or squashing of the thin side and roof sheets when the car is loaded. The curved contour of the body provides a convenient means of transferring load through the structure. Elliptical windows were used because they augment the rigidity of the car body in shear and torsion.

In addition to providing for the basic vertical, lateral, buff, and draft loads discussed in previous paragraphs, the car was designed to satisfy the A.A.R. specification loads for railway passenger cars. These specifications establish minimum requirements for the size of certain members and the design loads for other members.

The methods of stress analysis and the design used for this car are similar to those common in the design of all thin metal redundant structures. Some of these methods are common to all indeterminate structures. As mentioned before, an ultimate stress design method was used rather than the usual working stress method. This means that the designer multiplies imposed loads by a selected factor and designs structural members to their ultimate or yield stresses, instead of using working

FIG. 6. STEEL CAR BODY STRUCTURE
Floor, Sides, and Roof Form Closed Rigid Frame

stresses and designing members for imposed loads directly.

This method was used because structural materials of different strengths and properties were involved, and establishing working stresses for each seemed an unnecessary complication. Experimental coefficients for elastic stability formulas would have had to be converted, and the material stress strain curves adjusted. A more complete use of material is accomplished because the ultimate stress method established an equal factor of safety for both tension and compression members. Further design complication for thin metal structures is eliminated because the method affords more flexibility in fixing buckling criteria.

While buckling of thin panels in compression or shear must be considered at all times, a distinction must be made between compression buckling or critical stress, and the ultimate compression strength of a panel or series of panels. This statement may be amplified by using again the simple analogy of a thin-walled cylinder with its reinforcing rings and longitudinal stiffeners; but this time let us consider it as carrying an axial compression load. As load is applied, a time comes when the stress in the thin wall causes it to buckle; but the cylinder continues to carry load. It will continue to carry load until the ultimate column strength of the longitudinal stiffeners with their adjacent strips of skin, called effective skin, is reached. Likewise, if a thin metal panel is subjected to a shear load, the panel will buckle after the critical shear stress is reached, but it will continue to carry load until the ultimate strength of the diagonal tension field is exceeded. Both longitudinal and transverse stiffening members must then take the compression components for the diagonal tension field in addition to taking their normal load.

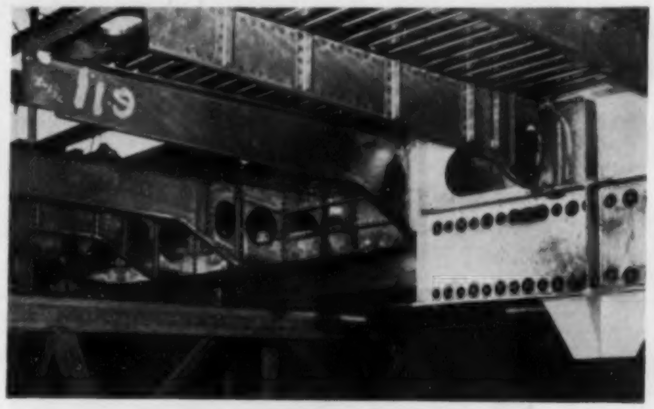


FIG. 7. CLOSE-UP OF UNDERFRAME

Fig. 8. Partially Completed Steel Car

Elastic stability formulas were used to determine both the buckling stresses and the ultimate strengths of compression and shear panels. The moment of inertia of the car body was determined by a method similar to the one described in "Stressed Skin Construction" by Carl F. Green (*Mechanical Engineering*, May 1936, page 279). For the ultimate bending condition, the moment of inertia of the car body must be based on the longitudinal stiffeners plus only the effective strip of skin of the compression side of the neutral axis. The entire sectional area is used for the tension side of the neutral axis. Ful use was made of available experimental data, but in addition a number of tests were conducted to determine the strength and characteristics of the materials used in the car. More tests were made to check buckling constants for the various conditions of fixity typical of this structure. Other tests were made to check design assumptions, and the various types of connections used.

The major portion of the car body was constructed of high-tensile, low-alloy steels. The center sill shear panels, and corrugated flooring were made of $^1/_2$ H 18–8 stainless steel. The structure was built up in assemblies and panels brought together for general assembly. The panels were made in a panel spot welder. Bulkheads, shear panels, and floor beams were fabricated with stationary spot welders Many connections were made with portable spot welders. While spot welding has an economic advantage in making up large panels or simple pieces requiring many spots, riveting and arc welding were used to advantage for connections where an elaborate equipment set-up was not justified by the few spots required.

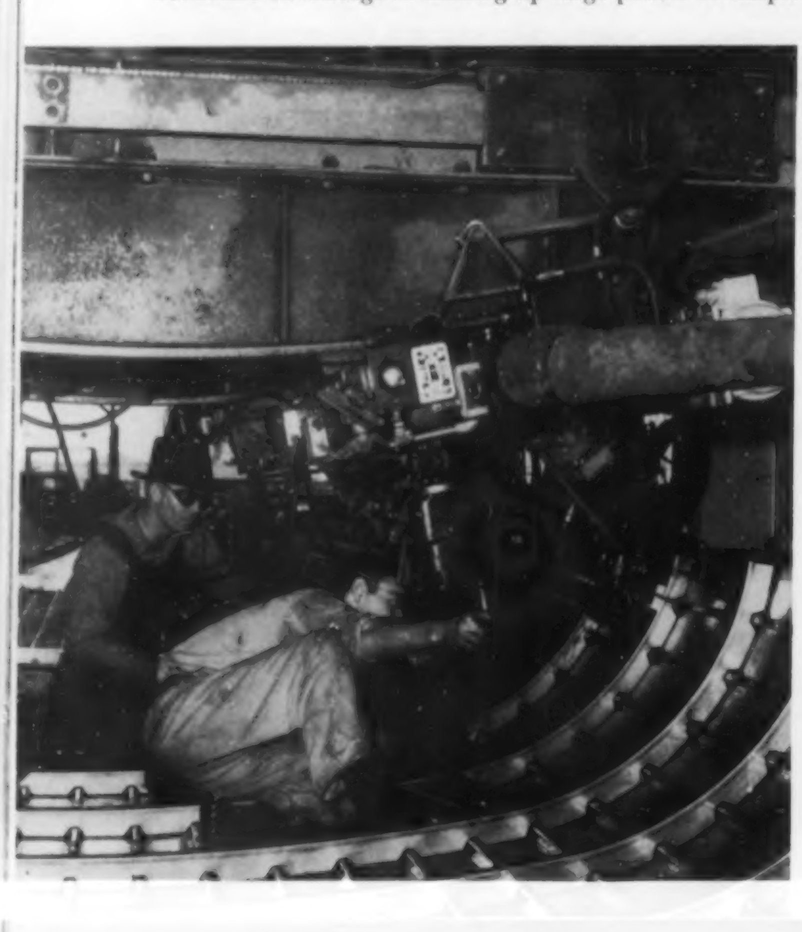


Figure 8 shows the first steel body car partially assembled. The smooth exterior is the actual load-carrying structure and is not a floating sheathing. This smoothness was possible because spot welds were used to connect the skin to the stiffening framework. Figure 10 shows a side panel in the foreground. The side sheets are 16-gage (0.060-in.), 75,000-lb per sq in., ultimate high-tensile low-alloy steel. The longitudinal stiffening members are hat sections and Z-members made of the same steel but are 0.048 in. thick. Fabrication is basically simple because the stiffening members are at right angles to each other. The window frames are sub-assemblies which fit between the longitudinal and the transverse framing members.

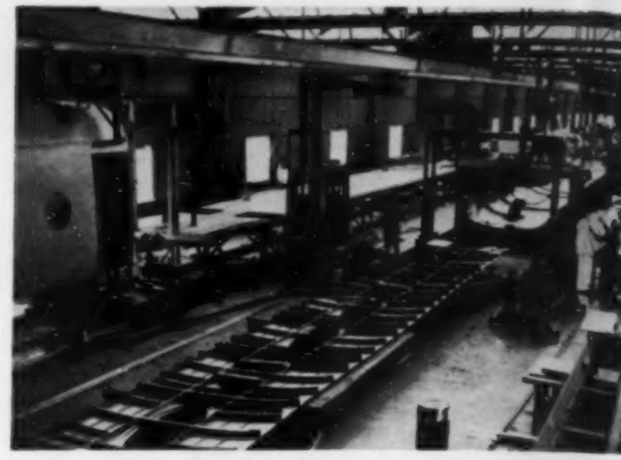


Fig. 10. Floor, Side, and Roof Units Fabricated Separately

A view of the roof panel in the panel spot welder is given in Fig. 9. The longitudinals are hat sections, and the transverse members are modified Z-sections. Both the longitudinal and the transverse members are made from 18-gage (0.048-in), 75,000-lb per sq in., ultimate high-tensile low-alloy steel. The roof sheet is made of the same material, and the roof panel is a very simple, rigid unit, easy to handle during construction.

A close-up of the underframe from below (Fig. 7) shows the center sill on top of which are the floor beams and shear panels. The riveted connection of the end frame to the center sill is also shown in Fig. 7. The center sill is a built-up section of plates and channels. It is $14^3/_4$ in. wide, 5 in. deep, and 67 ft $1^1/_4$ in. long. The floor beams are channels of varying depths fabricated from high-tensile low-alloy steel. These are spot welded to the edges of the center sill and to the central shear panels.

The shear panels are on top of the center sill between the floor beams, and provide a shear tie between the center sill and the corrugated flooring. The flooring shown in Figs. 6 and 7 is 0.038 stainless steel formed into $1^1/_4$ by $1^1/_4$-in. square corrugations. The end frames are arc-welded structures constructed of high-tensile low-alloy steel, having an ultimate strength of 80,000 lb per sq in., and are heavy enough to take the collision loads specified by the A.A.R.

The pendulum suspension and stressed skin body structure are combined in this type of streamlined construction to form a strong, stable railway passenger car, basically simple because its design is functional.

Fig. 9. Spot Welder at Work on Roof Panel
Longitudinal Hat Sections Stiffen Stressed Skin and Carry Tubular Beam Bending Loads

High-Head Pumping for Flathead Project

Earthquake Loads Influence Structural Design, and Model Tests Govern Acceptance of Centrifugal Pumps

By Russell G. Hornberger

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Hydraulic projects of the present day frequently demand the combined application of civil, mechanical, and electrical engineering skills. An irrigation pumping plant is as much a hydroelectric problem as is any power development. The Flathead plant, described by Mr. Hornberger, shows how steel and concrete details, as well as motor and electrical auxiliaries, depend upon pump selection, and how the pump and hydraulic auxiliaries are influenced in turn by some of the less familiar hydraulic properties of the system.

Adjacent to the Flathead Project in northwestern Montana is Flathead Lake, a large natural body of water which is the source of Flathead River. The pumping plant is on the river about $2^1/_2$ miles south of its source. A dam built across the river by the Montana Power Company about two miles below the pumps raises the elevation of the river above to that of the lake, and controls the elevation of both river and lake within definite limits.

The elevation of the pumping plant is such that an integral part of the substructure provides the entrance facilities for the water. A view of the completed plant from across the river is given in Fig. 1, and a view of the pipe lines from the top of the hill appears in Fig. 2. Water passes to the pumps from the river through trashrack bays and intake structure, and discharges through individual pipe lines 4 ft in diameter and 630 ft long, to a canal at the top of the canyon. The canal leads approximately $2^1/_2$ miles to the Pablo Reservoir, where the water is stored for use in the irrigation system.

Each pump outlet is provided with a check valve of the flap type, and a vent 30 in. in diameter is located near the extreme upper end of each discharge line. There are no other valves in the system. The pumps are started with the suction connections wide open and with the pump cases full of water, but with the discharge lines empty. They begin to pump immediately upon the start of rotation and fill the discharge lines as they are brought up to speed and synchronized. When they are stopped they operate in a reverse direction until the water in the discharge lines has receded. A general assembly drawing of a pump cell appears in Fig. 3.

Motors are of the vertical, synchronous type, rated at 3,000 hp each, 900 rpm, and operate at 2,400 v and a power factor of unity. A general view of the operating floor, Fig. 4, shows the motors after installation. Energy for the operation of the plant is received from the Montana Power Company at a substation adjacent to their generating plant at Kerr Dam.

The concrete substructure is divided into watertight individual cells as a protection against possible flooding. The entire structure, including the diaphragm walls between cells, was designed for continuity and full resistance at the corners. The main floor, with its beams for supporting the motors, was designed to limit the deflections obtained to values under 0.007 in. Chimneys were provided in the back wall of the substructure, which were later partly filled with concrete to provide an anchorage for the ells in the pump discharge lines. The natural rock in which the substructure was set was found to be seamed at the near face; consequently special reinforcement was added to distribute any load from this rock to the diaphragm walls and thence to the rest of the structure.

A flat concrete roof slab permits the transmission of earthquake and wind loads to the end walls and takes advantage of column restraint in the design of the roof girders. A fairly large ice load of 80 lb per sq ft was considered in connection with the roof girders. Continuity was assured at the bottom of the columns by means of welded connections between reinforcing bars extending up from the substructure and the column bases. This detail is shown in Fig. 5.

Each of the three pumping units has a rated capacity of 67 cu ft per sec at a total dynamic pumping head of 335 ft and at 900 rpm. The pumping head varies from 322 to 341 ft and is practically all static head. The inlet head (reservoir height above center line of pump) is positive; it is never less than 6 ft and is usually 8 ft or more.

As the size of the pump units selected was above the limit of size which has been produced by many manufacturers, it appeared very desirable, from the standpoint of insuring that the contemplated job would be successful, to require model tests before the manufacture of the full-size pumps was permitted. Arrangements were therefore made with the Bureau of Reclamation

Fig. 1. Completed Plant from Across the River

Power Is Supplied Over a Wood-Pole Transmission Line at 34,500 v, Stepped Down to 2,400 v at the Motors

FIG. 2. LOOKING DOWN PENSTOCKS TOWARD FLATHEAD RIVER
Field Joints Were Tested with Water Pressure in the Annular Space Between Inside and Outside Welds

and the California Institute of Technology for the services of the Institute's accurate laboratory, and each bidder was required to submit a model.

Specifications required that each model have a ratio somewhere between a minimum of 3 for 900-rpm pumps, and a maximum of $3^2/_3$ for 720-rpm pumps. The maximum ratio was determined by the capacity of the laboratory testing equipment. It was required that the model be homologous, not only for the impeller and the casing, but for the intake elbow and the discharge diffuser. In this way model tests could be conducted so as to determine overall performance as measured between intake and outlet points where flow velocities were reasonably low. The specifications required the prototypes to be tested for overall performance between exactly homologous points. Each bidder was required to state an expected efficiency, but this stated efficiency was subject to verification in the model test, and suitable adjustment was made for deviations. Bids were evaluated on the basis of the adjusted efficiency.

An interesting feature of the pump selection was a study of the critical speed for various combinations of pump shafts. The distance from the center line of the pump casings to the main operating floor on which the motors are located is 28 ft. It was thought, in general, that it would be desirable to omit an intermediate bearing for several good reasons, the principal ones being simplicity, long life, and freedom from bearing troubles. A definite decision was made to limit all the operating conditions to a speed falling well under the first critical speed of the pump shafts. But the study indicated that without an intermediate bearing the shafts would need to be not less than 17 in. in diameter for 720-rpm pumps, and not less than 21 in. for 900-rpm pumps. If suitable intermediate bearings were used, the pump shaft diameters, from the standpoint of critical speed, could be reduced to a minimum of 8 in. for 720-rpm pumps, or 9 in. for 900-rpm pumps. The saving in weight, cost, and manufacturing difficulties by the use of an intermediate bearing for each pump shaft was obvious. In the critical speed studies, an allowance of 30% was made for over-speed while the units were running backward.

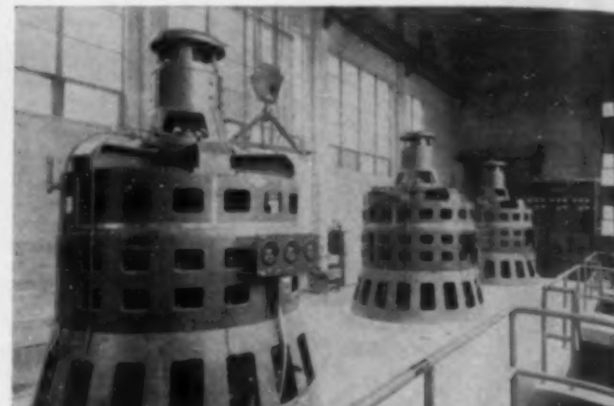


FIG. 4. GENERAL VIEW OF THE OPERATING FLOOR

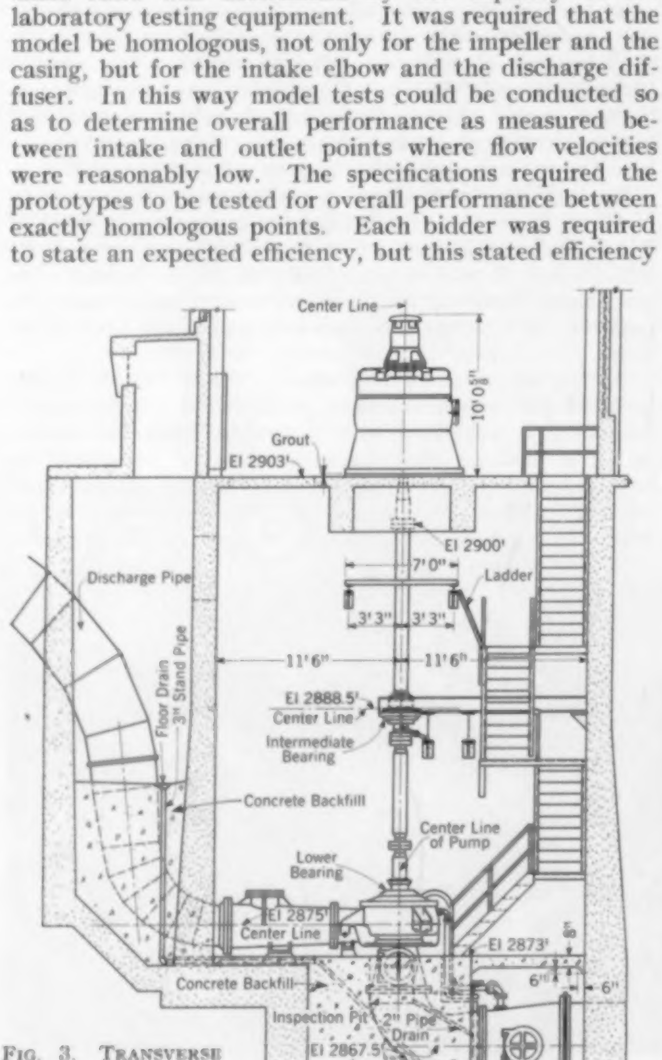


FIG. 3. TRANSVERSE SECTION THROUGH UNIT NO. 2

Only two bids were received on the pump specifications, one covering pumps to operate at 720 rpm, and the other on pumps to operate at 900 rpm. Both bidders submitted models that were tested at the California Institute of Technology Laboratory, and after evaluation it was formally determined that the 900-rpm equipment had the effectively low bid. The bid on the 720-rpm pump was considerably higher than that for the 900-rpm pump, and it was reasonably apparent that the difference in cost was the result of the selection of speed. Pump performance as expected from the model tests and as actually determined by means of field tests is given in Fig. 6.

Pump cases, which are of cast iron with unusually good physical properties, were hydrostatically tested in the shop to a pressure of 400 lb per sq in. During this test the deflections and recovery were noted. The pump impellers are of bronze. Partial balancing of the hydraulic thrust is provided. The design is such that complete balancing is never reached, and consequently there is always at least some downward load on the thrust bearings. The stuffing boxes are of conventional design and are provided with a supply of constant-pressure clear

water. Bearings are of the conventional Babbitted type. Lubrication is effected by a gravity system with a minimum head of 36 ft, and a normal supply of 1 gal per min of circulating oil per bearing. The oil passes from the bearings to a sump and is pumped from the sump to a head tank by means of gear pumps controlled by a two-float switch. Copper cooling coils are used in the oil-head tank.

Final selection of driving motors for the pumps was made after the pump models had been tested and the complete characteristics of the accepted model determined. Required torques presented an important problem. The breakaway torque was estimated to be relatively small, in the neighborhood of 10% of the normal running torque. The principal problem was connected with pulling in or synchronizing, because the pumps were to be started without a discharge valve. They would be operated in the cavitation range and would require more than normal torque at pull-in. There were two apparent solutions to this problem. One was to permit the motors to run as induction motors, principally on the amortisseur windings, until the pumps had filled the discharge lines and were operating at the normal point. The other was to attempt to pull the motors in while the pumps were operating in the cavitation range. The first procedure would have involved special amortisseur windings, with a severe heating cycle imposed upon the entire rotor structure. A brief study of the economics resulted in a decision to purchase motors with a sufficient pull-in torque to synchronize immediately upon reaching proper speed. The motors were also required to be safe for operation at 1,260 rpm, as demonstrated by a factory test.

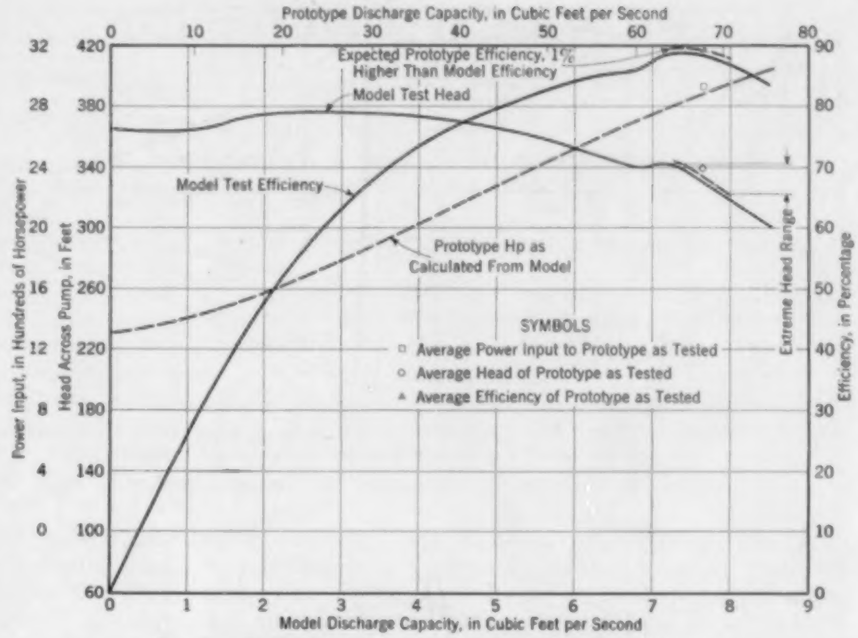


Fig. 6. Diagram of Flathead Pump Characteristics

The Hump in the Curves Is Usual for This Class and Specific Speed Range, But Not Always Distinguishable with Run-of-the-Mill Test Data

TYPE OF CONTROL EQUIPMENT

The control equipment selected was of the cubicle type, with automatic operation through the starting sequence, which employs reduced voltage from auto transformers, with closed transition switching. The circuits are so arranged that voltage is not removed from the terminals of the motor at any time during the starting sequence.

An interesting feature embodied in the control equipment is that of "field forcing." Under this scheme, when any motor is started, exciter rheostats of any running motors are short circuited, causing the running motors to be overexcited during the starting period. The field current of running machines is increased approximately 22% by this method, and this causes them to operate at approximately 95% leading power factor. This reacts through the impedance of the system to raise the bus voltage and overcome, at least partially, the voltage drop produced by the starting motor. The arrangement has worked very well.

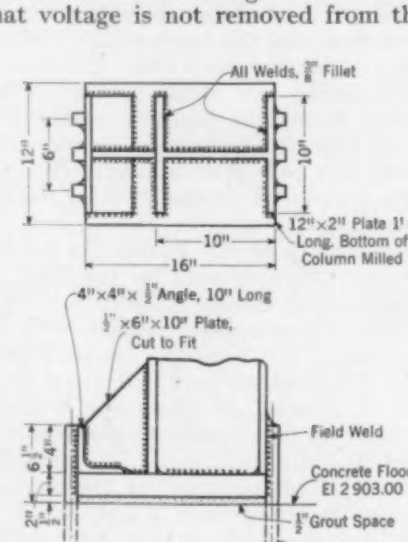


Fig. 5. Typical Column Base Detail

Selection of the elements of the hydraulic circuits was dictated largely by considerations of economy and reliability. From the standpoint of the pipe line alone, it was found feasible to use three separate discharge lines instead of one common line. This made possible the elimination of high-pressure discharge valves, which would have required either slow closing mechanisms, relief valves, or heavier pipe lines. Under the existing conditions it was found possible to use a minimum thickness of $^1/_4$ in. for 378 ft (or 59%) of each pipe line.

The transient conditions are rather involved. Upon power failure, or shut-off of power from a driving motor, the unit immediately starts to slow down. This produces negative pressure waves which travel to the upper end of the pipe line and are there reflected as waves of opposite sign. When the reflected waves reach the pump they cause an increase in head, which tends to accelerate the slowing-down process. The water column soon reverses and starts to flow back through the pump. After a short time the pump changes direction of rotation and rapidly comes up to maximum speed in reverse. After the water column has cleared the horizontal section of the discharge pipe line, it begins to recede in the inclined section and ultimately comes to rest with a zero effective head on the pump. In the meantime the pump continues to rotate with decreasing speed in the negative direction until it finally stops.

During the foregoing procedure the operation pump passes through three categories of operation: (1) with the direction of rotation in the positive or normal direction and the flow of water in the normal direction; (2) with the flow in the negative direction and the direction of rotation positive; and (3) with the flow of water and the direction of rotation both in the negative

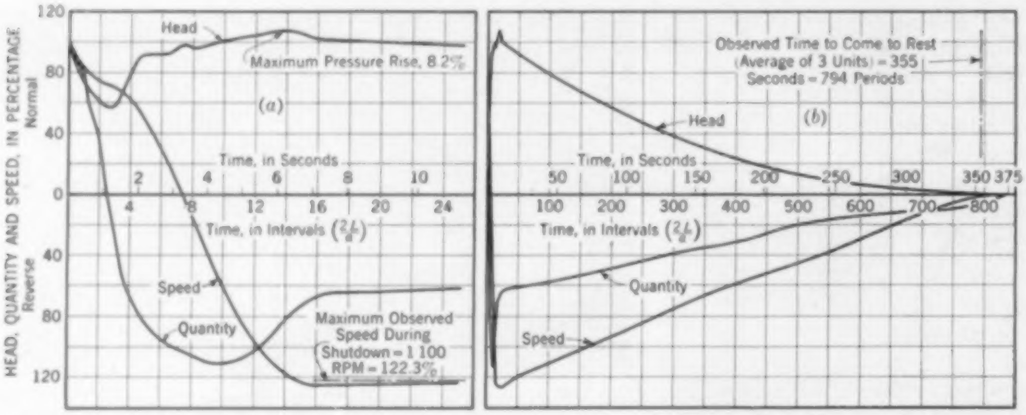


FIG. 7. MEASURED FIELD VALUES SHOW CLOSE CORRELATION WITH CALCULATED TIME HISTORY OF THE TRANSIENTS FOLLOWING SUDDEN POWER LOSS

(a) First 25 Time Intervals Magnified, (b) Curves Complete to Point of Rest

direction. In order to compute the transients it is necessary to have available complete characteristics of the pumping unit to cover all three of the categories mentioned. This information was secured during the model tests.

A similar problem had already been investigated by R. M. Peabody for the Metropolitan Water District of Southern California, and published in the *Transactions* of the American Society of Mechanical Engineers for February 1939. Mr. Peabody's published computations were made by a point-by-point method of integration in which the interpolation of a point in a plane was necessary. It was suggested by R. T. Knapp, M. Am. Soc. C.E., of the California Institute of Technology (and also mentioned by Mr. Peabody in his article) that a graphical method such as that proposed by Bergeron, and discussed, with fairly complete bibliography, by Prof. R. W. Angus ("Water Hammer Pressure in Compound and Branched Pipes," TRANSACTIONS, Am. Soc. C.E., Vol. 104, 1939, page 340) would be of assistance in shortening the computations. That principle was followed and was found to expedite the computations considerably.

The time history of the pipe-line pressure, pump speed, and quantity of discharge are shown in Fig. 7(*a*) to an enlarged scale for the first part of the shutdown period and in Fig. 7(*b*) for the complete period. It will be noted that the relatively high WR^2 (inertia) of the pump unit minimizes the pressure rise in the pipe line. Equipment has not been available for measuring the complete transient history in the field, but measurements have been made of the maximum speed in reverse and of the time required for shutdown. Approximate observations have also been made of the pressure rise. All three values correspond relatively closely to the computed values.

PROBLEMS OF PIPE-LINE CONSTRUCTION

Pipe-line construction was in itself a problem. Each pipe line is tangent to the hillside for a distance of 570 ft. The hill has a fairly uniform slope of approximately 1.5:1 with a vertical rise of 316 ft above the pump-house floor. The lower 130 ft, vertically, of the hill is composed of a glacial clay, with lenses and seams of fine sand and with silt that becomes quicksand under certain moisture conditions. The upper 186 ft of the hill is composed of glacial silt with very poor stability against erosion and a relatively low bearing power. The presence of ground water in the form of perennial springs was evident before work was started, and necessitated extensive drainage operations. Tile and perforated pipe were laid through the saturated areas to a common well, from which the water was piped to the river. The system has been very effective in drying the entire area. Probably most of the flow came from stored water, for it has decreased materially with time.

Pipe lines are supported by rigid ring girders at a spacing of 40 ft. Rockers provided at each ring girder insure that the bearing pressure will be approximately normal to the hillside, and make possible considerable reduction in the footing pressures under each intermediate support. The 40-ft spacing of ring girders is somewhat less than the theoretical economical spacing, but represents the greatest length of pipe which it was convenient to ship. Because of the poor bearing properties of the supporting soil, the pipe lines were designed as continuous girders and the stresses were kept low enough so that one support could fail completely without causing the stresses from the resulting 80-ft span to exceed the elastic limit of the material. The individual sections were given a factory hydrostatic test to $1^1/_2$ times the working pressure.

Field joints are of the belled and inserted type, welded inside and outside. Each joint was tested with water pressure in the annular space between the inside and outside welds. This method was found to be advantageous, for it disclosed numerous small leaks which were repaired before the interior protective coating was applied at the joints. The pipe lines were protected on the outside with red lead in a synthetic vehicle and a top coat of aluminum paint. The interior surfaces were given a coating of spun coal-tar enamel.

Excavations necessary for the pumping plant structure gave the hillside back of the plant a slope greater than could be permanently maintained. After discussion and investigation, it was decided to terrace it, and this was done in approximately 10-ft steps. The vertical faces of the benches provide no resting place for snow and rain, and the horizontal surfaces are graded to provide drainage to each end. The results have been favorable during two winter seasons. The operation of this plant during the past season has been very successful. It is expected from surveys and other indications that 1941 will be a year of relatively low water supply, and the pumping plant should aid materially in compensating for this lack.

Activities of the Indian Service are directed by the Indian Office, headed by the Hon. John Collier, Commissioner of Indian Affairs; A. L. Wathen, acting chief engineer, supervises irrigation work, including power and pumping. G. L. Sperry, senior engineer, is in charge of the Flathead Project under the general supervision of W. S. Hanna, M. Am. Soc. C.E., District Engineer. Construction was accomplished by project forces. Barry Dibble, M. Am. Soc. C.E., consulting engineer, supervised the preparation of the designs, and the writer, under the supervision of Assistant Director H. V. Clotts, M. Am. Soc. C.E., was actively engaged in the preparation of the designs, equipment specifications, and supervision of construction.

Harbor of the Sun—San Diego, Calif.

Forward-Looking Development Enhances Site of Annual Convention in July

By R. H. Van Deman

Major General, U.S. Army, Retired; President, San Diego Municipal Harbor Commission, and Member, State Board of Harbor Commissioners for San Diego

TODAY one of the great ports of this hemisphere is San Diego Bay, the "Harbor of the Sun," which was discovered on September 28, 1542, by the Portuguese navigator, Juan Rodriguez Cabrillo. But it was not until 60 years later that it was officially named San Diego by Don Sebastian Viscaino. A century and a half more passed before a European settlement was established on its shores. On July 1, 1769, the expedition under Don Gaspar de Portola and Fra Junipero Serra established camp at what is now known as Old Town.

So much for the early history of San Diego Bay. This southwestern-most port of the United States (Fig. 1) is a natural landlocked harbor with an area of 22 sq miles. It is considered one of the ten great natural harbors of the world. It has no strong currents and is comparatively free from fogs and high winds. It is considered one of the safest of all harbors.

Several rivers at one time emptied into the bay, but various engineering projects have eliminated these, preventing all silting. As provided by nature, the bay had limited value for modern shipping, owing to extensive areas of comparatively shallow water. Active development of the port to accommodate modern shipping began in 1891, when the War Department started its first dredging project. This was followed in 1912 with a city bond issue of $1,400,000, for the construction of a municipal pier and other improvements. By the end of 1915, the Broadway Pier, a structure 130 ft wide and 800 ft long with cargo sheds and other facilities, had been completed and a channel dredged with a depth of 32 ft to permit ships to come alongside from the main channel. In the ensuing years, the city has expended approximately $5^1/_2$ millions in harbor improvements, and the federal government has spent in excess of 6 millions on the bay.

Fig. 1. San Diego Area and Bay
Areas of Fill Shown Hatched
Areas of Dredging Shown Stippled

Dredging in San Diego Bay accomplishes three major purposes: deepening to accommodate larger vessels, reclamation of valuable ground with the dredged material, and elimination of unsightly mud flats. The Tidelands Act of 1911 placed all the tidelands in the city under the control of the Municipal Harbor Commission.

Handling Dredge Pipe for Harbor Work

In 1927, the city voted $650,000 in bonds to construct a municipal airport. This money was all expended in dredging the bay and reclaiming tidelands, resulting in an airport of 212 acres and the dredging of a turning basin in the harbor with a radius of 300,000 ft and a depth of 36 ft. This dredging of a turning basin was technically outside the sphere of control of the city, but the fact that the city was willing to do this important work brought a favorable reaction from the Navy, the Army Engineer Corps, and commercial shipping. The result has been that the Army engineers and the Navy have been more than willing to cooperate with the city on further improvements.

In 1933, there was danger that lack of space in San Diego Bay would make it necessary to move some of the light cruisers based there to Long Beach. The city immediately authorized the Harbor Commission to dredge an area known as Alexander Shoals, to make available sufficient deep water to accommodate all the light cruisers. Again, this willingness of the city to cooperate resulted in further improvements at federal expense. In 1934, the Army engineers widened the entrance channel to 800 ft and deepened it to 40 ft to accommodate the largest of ocean-going vessels; and in the same year they widened the main channel of the bay, also reclaiming an additional 600 acres of land for the U.S. Naval Air Station on North Island.

Subsequent dredging completed in 1941 by the Army engineers has further improved the harbor entrance by removing the tip of North Island, known as Zuninga Shoals, to a depth of 36 ft, and also dredging to a depth of 36 ft an area just inside Ballast Point, known as the Middle Ground. This improvement has made it possible for the large aircraft carriers, *Lexington* and *Saratoga*, to enter the harbor with complete safety.

Port of San Diego—General View

In 1939 and 1940, a Navy project to construct concrete moorings for the aircraft carriers on the North Island edge of the main channel was completed. This project entailed the construction of huge concrete blocks under water; and the building of hollow concrete cylinders, which were floated into place over these previously prepared bases, fastened down, and then filled with concrete, making very substantial moorings for the large carriers. Pairs of these moorings were then connected by a bridgework, making in effect a substantial pier alongside of which the carriers may easily be moored, with immediate access to the Naval Air Station for the handling of personnel, supplies, and equipment.

At La Playa a yacht basin was recently dredged to a uniform depth of 20 ft and the area protected from southerly storm winds by a sandspit, created by throwing the dredged material on top of an existing shoal area. There was considerable controversy as to whether this protective spit should be connected to the main shore, forming an enclosed basin, or whether it should be in the nature of a long narrow island, with an opening at the shore end. The latter was finally decided upon, in the belief that otherwise the basin might collect floating debris and become a nuisance.

Reclamation of tideland areas in San Diego Bay is simplified and made comparatively inexpensive by the fact that bulkheading is not necessary. The lack of strong currents and high tides eliminates danger of sloughing. Therefore all that is necessary is to throw up a dike of the dredged material along the bulkhead line and then to pump other material in behind. The material dredged from the bay is a combination of sand, shell, and clay, which packs rather tightly and has very good bearing qualities. Within a very short time these reclaimed areas become covered with wild plants of various types.

In order to secure appropriations for harbor dredging and improvement, the port usually must show that these improvements are absolutely necessary for the handling of commercial shipping. In spite of the practical elimination of commercial shipping on the West coast, and particularly from the port of San Diego, due to labor strife in the shipping industry, Congress appropriated $4,183,000 in 1936 for dredging in San Diego Bay. This appropriation was made possible only in the interest of the Navy and national defense. San Diego Bay is considered by the Navy to be the most ideal base of operations for the fleet in time of peace or war. The Navy has always utilized this bay to the maximum, making necessary the dredging of additional areas so that aircraft carriers, destroyers, cruisers, submarines, and other light forces of the fleet could be based on this port.

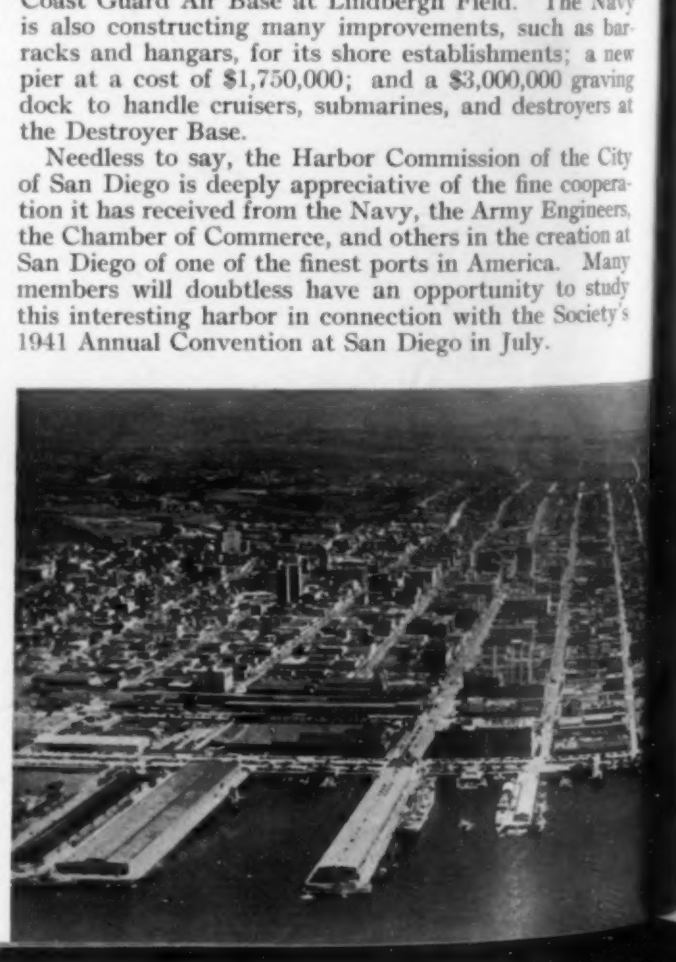
This dredging is nearing completion. To enumerate some of the more valuable results: A seaplane basin 10 ft deep, 1,500 ft wide, and 2 miles long has been created adjacent to Lindbergh Field, the dredged material doubling the size of the Field, adding 500 acres to the U.S. Marine Base, and several hundred acres to the U.S. Naval Training Station; Coronado has gained about 60 acres of new land; and National City is securing the reclamation of 360 acres of very valuable industrial waterfront area, of which 96 acres have been deeded to the Navy for extension of the U.S. Destroyer Base. The prime purpose of this tremendous dredging program, which was to increase anchorage areas in the harbor for naval vessels, has of course been accomplished.

In March 1941, an additional contract of $3,875,000 was awarded by the Navy Department for the dredging of a huge seaplane basin in the South Bay area adjacent to the Silver Strand. This project will create 3,300 acres of calm water, 10 ft deep, for seaplane operations, and will reclaim 500 acres of land on the bay side of the Silver Strand. Part of this land will become the property of the State Park Commission, and other areas will be used by the Navy for seaplane hangars, ramps, and shops.

With the completion of present projects, there will have been spent on dredging in San Diego Bay since 1891 a total of approximately $11,000,000. These funds have come from the War Department, the Navy, the city and state, the SERA, the WPA, and private funds. Over 100 million cu yd of material have been dredged from the bottom of the bay and used in the reclamation of several thousand acres of very valuable land. It is safe to state that the present value of this reclaimed land is considerably more than the cost of dredging and reclamation.

At the present time (June 1941) the Navy's investment in permanent shore establishments around San Diego Bay totals about $80,000,000. These establishments include the Fuel Depot, Training Station, Marine Corps Base, 11th Naval District offices and storehouses, Destroyer Base, Naval Air Station, Naval Hospital, and Naval Radio Station. In addition, there is the Coast Artillery Base at Fort Rosecrans on Point Loma, and the Coast Guard Air Base at Lindbergh Field. The Navy is also constructing many improvements, such as barracks and hangars, for its shore establishments; a new pier at a cost of $1,750,000; and a $3,000,000 graving dock to handle cruisers, submarines, and destroyers at the Destroyer Base.

Needless to say, the Harbor Commission of the City of San Diego is deeply appreciative of the fine cooperation it has received from the Navy, the Army Engineers, the Chamber of Commerce, and others in the creation at San Diego of one of the finest ports in America. Many members will doubtless have an opportunity to study this interesting harbor in connection with the Society's 1941 Annual Convention at San Diego in July.



Some Larger Developments—
B Street and Broadway Piers

Highway Research in Indiana

By K. B. Woods, Assoc. M. Am. Soc. C.E.

Assistant Professor of Highway Engineering, Joint Highway Research Project, Purdue University, Lafayette, Ind.

Present as well as future trends in highway development are influenced by availability of the petroleum supply, changes in design and consumption of automobiles, and effect of the trend toward airplanes. The relative influence of these factors on highway research is here presented, together with the plan of study now being followed by the Indiana Joint Highway Research Project. This paper, originally given before the Highway Division at the Cincinnati Meeting, shows how current studies are preparing for the highway of tomorrow.

Any state has an enormous investment in its highway system. That this investment, together with the expenditures for improving additional miles, is worth while can be seen from an analysis of the far-reaching effect of the highway on the economic welfare of the population. The importance of highway systems, particularly express roads, to national defense, is obvious considering the trend toward highly mobile army units.

Indiana has 75,000 miles of highways, and 10,000 of these are in the state system, a quantity 100% higher than that of ten years ago. Since available funds have remained at an almost constant level during this period, the State Highway Commission is now facing a difficult problem. A unique plan has been adopted for solving this problem in part. Two governmental organizations are cooperating in an extensive research program—the State Highway Commission and Purdue University. The functional organization operated by these two is called the Joint Highway Research Project.

This project was inaugurated in 1936 and authority was given the State Highway Commission to transfer funds to Purdue University by an Act of the State Legislature on March 11, 1937. A plan of study has been formulated and a research staff of 30 to 40 men has been organized to handle the many studies under way.

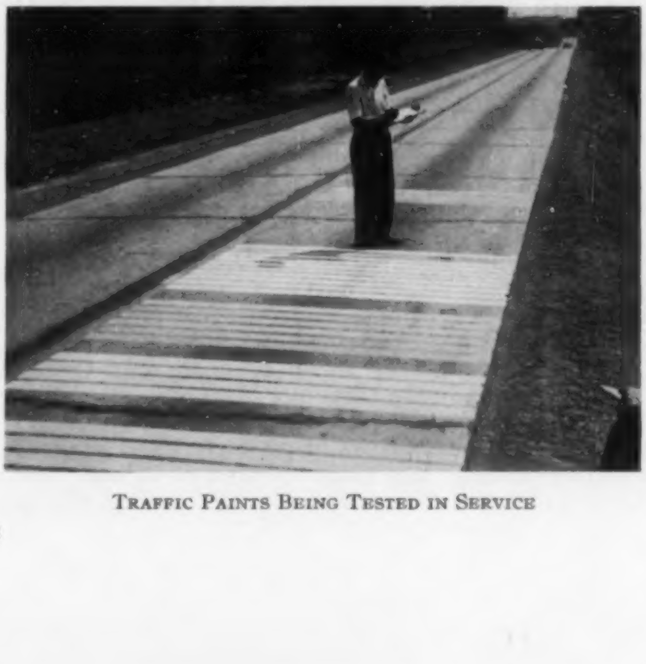
One of the outstanding features of the project is the utilization of a large number of graduate assistants on a part-time basis. Outstanding men, from colleges, universities, and highway departments all over the country, are selected as graduate assistants and are assigned a highway research study as a thesis for their master's degree. Thus, both academic and practical information is obtained for use by the highway industry in Indiana.

To offset the use of young men in research, a small full-time and experienced staff is provided to supervise the work of the graduate assistants. Each research worker attacks his problem by reviewing the results of previous investigations, so as to avoid duplication. This done, a carefully prepared plan of study is developed. The individual studies are of relatively short duration; however, the selecting and blending of these numerous lines of research presents a problem in coordination that is necessarily more far reaching than individual studies. Consequently, a long-range plan is required as a guide in formulating a program that will be pertinent to the current problems when the solution is reached. The success of the work depends to a great extent on the type of subjects chosen for investigation and the caliber of the personnel available to perform this research.

In developing a basic plan of study for as large an undertaking as this, two general types of studies immediately present themselves: (1) those that are practical, timely, of relatively short duration, and pertinent to a pressing problem or problems, and (2) those that are more fundamental and require many months or perhaps years of research. The practical problems may be termed "routine research" and the more fundamental ones "academic research." It can be seen, then, that that part of the plan of study devoted to practical problems is continually changing.

That part of the plan of study devoted to fundamental research must be entirely different. A master plan must be drawn so that the entire program will lead to some definite goal. Studies must be timed and coordinated so that the answer to one problem will provide a stepping stone to the solution of another. This is indeed a difficult assignment and a long-range attitude must be taken. If the results of research are to be applied a few years after inception of the study, it is obvious that some consideration must be given to present and possible future highway trends. For example, the shortage of adequate petroleum supplies in France and other European countries has retarded the progress of the automotive industry there, which in turn has obviated the need of extensive highway systems that exists in the United States. The occurrence of similar conditions in this country might result in a radical change in the entire highway picture.

Estimates on the quantity of petroleum available are difficult to make since new fields are being discovered constantly. The supply known to be available in the United States alone is sufficient to last only about 15 years, based on the annual average consumption for the past several years (*Minerals Yearbook*, U.S. Department of the Interior, Bureau of Mines, 1939). However, enough bituminous and sub-bituminous coal is known to be available to meet the present annual demand for fuel, as well as for the manufacture of gasoline and fuel oil to meet current demands for at least two thousand years. These estimates do not include the factor of possible decrease in annual consumption because of new techniques that might be developed in refining processes or in improved efficiency of gasoline motors. Neither do they anticipate the use of synthetic gasolines. Although this is a difficult matter to forecast on the basis of available



Traffic Paints Being Tested in Service

An Ideal Location for Studying Driver Reaction to Signs

information, it is probable that both costs and supply of petroleum products will not change materially in the next decade. Such being the case, the influence of possible changes in the petroleum supply on the highway systems of the country can be discounted.

It has often been said that foreign cars are designed by the tax collector. In the United States he has not yet assumed this degree of influence nor is our design based upon such rigid economy of materials and performance. The automobile of today has resulted from a combination of the buggy and stationary engine industries, and basically the design has not changed. Radical changes in body design are impossible in a short period of time, although a comparison of a 1941 model with a 1914 model makes it evident that we are being "sold" a more scientific design in spite of our natural resistance to change. These subtle changes in body design may soon provide facilities for a radical change in power-plant design and location. The transfer of the weight of the motor from front to rear will increase riding comfort and traction and reduce tire wear and noise.

Regarding a possible increase in consumption of cars in this country, an inspection of Fig. 1 shows that after about 1930 there has been only a slight yearly increase in motor-car registration as compared with about a 200% increase from 1920 to 1930. Possibly the registration curve will become flat within a few years—it may even turn downward in the face of world events. From the standpoint of highway research and design it is reasonable to expect a demand for safer highways to accommodate slightly more and faster cars. While this factor will be of considerable concern with respect to express and primary highways, the situation will be most critical on the secondary roads.

Undoubtedly the airplane will influence automotive transportation in the next few years, particularly long-distance travel. As early as 1935, France and Germany planned to use their paved highway system as runways for airplanes. A modified plan could be adopted for increasing safety of civil aircraft in America. But few refinements are necessary in designing highway rights-of-way to make them emergency landing fields. The removal of obstructions such as trees and headwalls is perhaps the sole feature that does not conform to present-day trends. Provision for emergency landings at intervals along the highway would stimulate private plane travel. The ultimate effect the plane will have on the highway cannot be foreseen, although it is apparent that planes will be produced in increasingly larger numbers, and this, in time, may limit the need of express roads. However, it may be assumed that the airplane will not affect the highway systems of the country as a whole until it can be more conveniently parked.

Data from hearings before the Committee on Roads, 75th Congress (Fig. 2), show the proportions of different classes of highways, based on materials of construction and types of highways. It is interesting to note the projected increase in the use of stabilized roads. The secondary system will improve in quality, and the improvement of these secondary roads must be accomplished by some form of stabilization using low-cost materials. Since the secondary types are generally so inadequate for modern traffic, their large mileage makes research in this field very desirable.

At the present time the project has fifty studies that are complete, in progress, or being inaugurated. In order to give the reader a perspective of these researches, a few of the more importance ones will be described.

Realizing the importance of drainage to highway performance, the project has initiated a study to investigate some of the more basic factors influencing the design of drainage installations. A total of over fifty sand and electrical models have been tested to date covering typical highway drainage installations, and flow nets have been constructed to trace the path of water flowing to the drain. At the same time, various soil types are being tested for permeability and capillarity characteristics. These latter tests are also being performed on soils with bituminous admixtures in an endeavor to obtain information for use in stabilization and subgrade treatment.

The problem of determining the distribution of stress in the subgrade beneath a pavement is being studied by means of photoelastic models. Gelatin is used as the medium, because it can be molded easily or cut into various shapes to simulate road-bed sections; also it is possible to construct models of this material which are representative of stratified soils. An evaluation is being

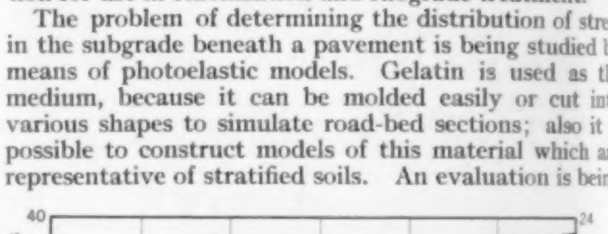


Fig. 1. Comparison of Motor-Vehicle Registration Trends
Curve *A* from Bureau of Public Roads, 1939; Curve *B* from John W. Scoville, Chief Statistician, Chrysler Company, 1935; Curve *C* from American Petroleum Institute, 1934

made of these stresses in relation to traffic loads so as to ascertain the maximum unit load that the subgrade will be required to carry.

Closely related to the stress distribution problem is the study of the shearing resistance of soils. The effect of bituminous admixtures on the soil, together with the effect of density, curing, and moisture content, is being evaluated by means of the triaxial testing equipment. The relationship between moisture content and strength is of special significance in problems of drainage, since it is necessary to determine the moisture content at which a particular soil fails to support the road surface. On this strength basis, modified by other factors, the necessity for drains can be determined. Supplementing the triaxial studies is an attempt to determine the optimum

bitumen content of bituminous-soil mixtures by a combination of several procedures, including in particular a "minitrack" testing apparatus.

Studies of frost action in soils have yielded some valuable information, particularly from the standpoint of the effect of bitumens, portland cement, and chemical admixtures. One of the observations from these studies was that a surprisingly small quantity of either calcium chloride or sodium chloride practically eliminated frost action in certain soil types. At the same time both field and laboratory investigations have indicated that such chemicals, incorporated in stabilized bases, migrate to the underlying subgrade. As a result of these observations, a systematic investigation is under way covering the effect of the several variables on both the performance and migrating characteristics of these materials in subgrade soils.

In order to evaluate the results obtained from the many laboratory studies, extensive field experiments have been carried on over a period of several years. Test roads are used primarily and are located on the road systems of both the Commission and the counties as well as on a tract of land near the University. Such roads provide an opportunity to study the service behavior of low-cost pavement types with varying designs under the conditions of weather, traffic, and subgrade soils encountered in Indiana. Subgrade soil temperatures, fluctuations in moisture content, and changes in ground-water table are some of the many detailed observations made on such roads.

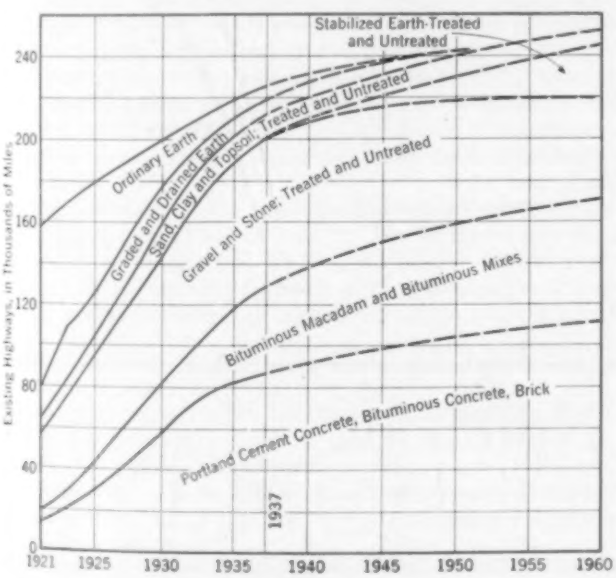
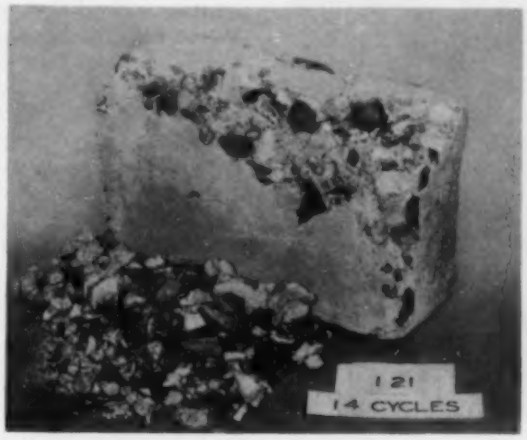


FIG. 2. SURFACE DEVELOPMENT, FEDERAL-AID HIGHWAY SYSTEM
Prior Experience, 1921–1937, and Estimated Future, 1938–1960

Another series of studies of major importance to the highway industry is that of bituminous materials. A few years ago the majority of bituminous materials were of the hot penetration grade and were mixed with clean hard stone, sand, and mineral dust. However, the advent of the low-cost road, demanding the use of local mineral aggregates, including soil, has forced the development of many specialized bituminous materials to meet these various requirements. In the past few years the proportion of bituminous surfaces to total surfaces in state highway systems has increased from less than 50% to well over 60%. The rate of gain per year has been over 100% as compared with a gain of roughly 25% for all other road types. The major part of this increase has been within the low-cost group—those types known as surface treatment, road-mix, and cold-laid plant mixtures. This rapid growth in the bituminous field, with its development of new products and the utilization of local aggregates and soils, has given rise to many new problems. The demand for basic information on the various types of bituminous materials, aggregate, and soil combinations has proved to be a real challenge to research workers.



CONCRETE DISINTEGRATION RESULTING FROM USE OF BAD CHERT AS PREDOMINANT AGGREGATE

In an effort to solve some of the problems encountered in surface treatment work, a test road ten miles long was constructed in 1939. Preliminary studies and investigations were made of the original road prior to the construction of the 51 test sections. The type of bituminous material, the source and size of aggregates, and the amounts of these materials were varied.

Although research workers have shed much light on the composition, structure, and chemical and physical properties of asphalt, no test has yet been devised that will measure the quality of an asphalt. A study recently started by the project was undertaken for the value it may have in evaluating that property of asphalt. This study is being attacked by a microscopic examination of characteristic patterns formed on etched bituminous surfaces.

The project has recently inaugurated an interesting series of investigations on portland cement concrete. Since 40% of the Commission mileage is paved with concrete, it is logical that research on this material be included in the plan of study. The problem of durability, both from the standpoint of laboratory testing technique and field performance is being studied by this project as well as by other research organizations. The project endeavors are being concentrated on the durability characteristics of concrete, including in particular the relationship of the amount and size of the pore spaces to water absorption (saturation coefficient). Scaling, caused by ice-control chemicals, is being studied together with the bleeding, water regain, and fatigue characteristics of both portland cement concrete and blends of portland with natural cement.

Information on the characteristics of aggregates should definitely be included in a broad plan of highway research. An investigation of chert will be completed in the near future. This is of particular importance since there has been a great amount of confusion concerning specified limitations of this material in aggregates. Certain types of chert are generally recognized as deleterious in concrete, primarily because of their tendency to expand with changes in moisture and temperature, causing "pop-outs" and other forms of disintegration. The study covers the characteristics of this rock, the development of tests, and the determination of practical specification limits in concrete aggregates.

COMPACTION OPERATIONS ON ONE OF THE PROJECT TEST ROADS

Such an investigation must naturally utilize information and technique employed in many fields. To illustrate, one approach is the determination of the chemical analysis; a second is the examination of thin sections under the microscope; and a third is the use of a trained geologist to identify the various sources. This particular study is a good illustration of the value of having a research organization located on the campus of a large university, where specialized scientific knowledge is concentrated.

Research and the adoption of sound principles in highway design, routing, and marking have reduced the traffic accident deaths per total miles driven. This has been accomplished in spite of the fact that today there are more drivers and faster cars on obsolete roads. Although an inspection of Fig. 3 shows definite improvement in the traffic accident trends, the rate is still excessive. If research can save even a few lives the money spent will be repaid many times. The project study of driver reaction is concerned with some of the human factors involved in safe vehicle operation, such as the attitude toward warning signs. The objectives of this study are: (1) to determine whether or not "warning signs" reduce speeds; (2) to determine the optimum distance at which these signs should be placed in order to call a driver's attention to anything ahead that requires the exercise of caution, a reduction of speed, or any other action that might be appropriate for efficient and safe driving; and (3) to determine the effect of distance and the size of the component parts of the signs on driver behavior.

With the increased use of traffic paints, engineers and persons responsible for the purchase of such materials have come to realize the importance of satisfactory specifications. Much more consideration has been given to these factors in recent months, because of the disturbed state of world markets consequent to the war situation. Already tung oil is scarce, and the possibility that costs of some ingredients will increase to a prohibitive point is imminent. The first object of the research program on traffic paint is to correlate the service performance with laboratory tests on a number of different paints, to evaluate these tests, and to develop more significant tests for paint qualities if they seem necessary. Test paints are being subjected to various conditions of service in an effort to evaluate the factors affecting their life. Also, since paint is a material that cannot be purchased in the form used for service, but is subject to many variables in application, the study includes an evaluation of surface preparation and methods of application, as well as weather conditions and other controlling variables.

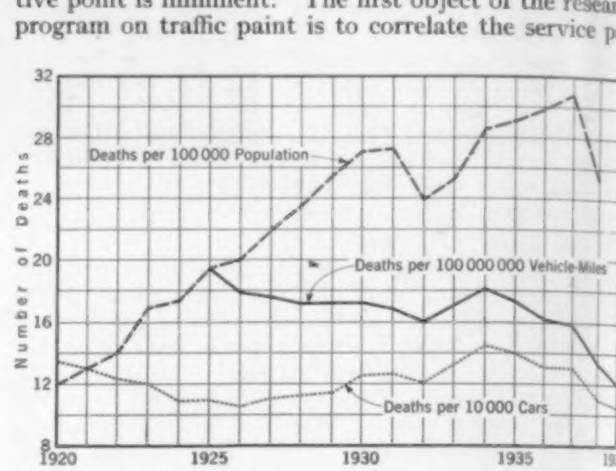


FIG. 3. U.S. TRAFFIC FATALITY RATE, 1920–1939

It should be recognized that the economic value of highway research will increase in the face of possible adverse world conditions. The Indiana cooperative research organization is in itself an example of the present trend toward economic design in highway engineering.

Engineers' Notebook

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Computation of Flood Flows by Slope-Area Method

By A. H. DAVISON

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FLOOD flows, with their attendant scouring of river channels, washing out of bridges, and other damage, often produce abnormally high discharges accompanied by backwater effects from obstructions washed into the stream channel. Hence such flows usually require individual analysis and solution. The immediate objective of this discussion is to present a method for the accurate determination of flood discharge and to provide a sound explanation of the attendant factors.

Flood flows often occur where there are no available gaging-station records. A determination of the discharge by reference to a gaging-station rating curve, even if available, is not conclusive where there is any backwater effect from washed-out bridges deposited in the

stream channel downstream or from debris lodged against the piers of a bridge that failed to wash out. The slope-area method of computation of discharge can be applied if data obtained at the site include a survey of available high-water marks and suitable cross-sections of the stream channel. The analysis of these data by application of the Chezy and Kutter formulas, or by the Manning formula, is the usual procedure.

In an article in *Engineering News-Record* (August 23, 1934), the writer offered a graphical solution based on the Chezy and Kutter formulas. Uncertainties inherent in any graphic analysis, such as faulty or indeterminate intersections of converging lines separated by a small angular difference, make desirable the development of a sound analytical treatment of the problem. The method of treatment here described applies the Manning formula and depends on the solution of simultaneous equations.

The essential principle is that there can be but one value of discharge that satisfies the data. The following example of computation illustrates the method. In this example the data apply to the July 1935 flood conditions on Glen Creek near Watkins Glen, N.Y., and appear in the U.S. Geological Survey Water-Supply Paper 773-E. The Manning formula is stated as follows:

$$V = \frac{1.486}{n} R^{2/3} s^{1/2}, \text{ or } Q = \frac{1.486}{n} A R^{2/3} s^{1/2} \quad \ldots\ldots (1)$$

in which Q = discharge in cu ft per sec
V = average velocity in the cross section in ft per sec
R = hydraulic radius in ft
A = area of cross section in sq ft
n = coefficient of roughness
s = friction slope

Friction slope is the slope of the energy gradient and does not coincide with surface slope unless the mean velocity remains constant from point to point along the river. The energy gradient is a line joining the energy head at the three cross-sections in the example, and the energy head at each cross-section is the elevation of the water surface plus the velocity head at that point.

In Fig. 1 appears the water-surface profile determined by the high-water marks located at A, B, and C. The corresponding values of area A, hydraulic radius R, and wetted perimeter P, for the three cross-sections A, B, and C, are included in Table I.

TABLE I. INITIAL DATA ON GLEN CREEK FLOOD PROFILE

Section	Distance (Ft)	Water Surface El. (Ft)	A (Ft²)	P (Ft)	R (Ft)	$R^{2/3}$ (Ft$^{2/3}$)
A		103.9	1,377	104	13.2	5.58
	426					
B		98.9	1,136	95	12.0	5.24
	480					
C		93.4	1,293	110	11.7	5.17

The object is to determine the correct values for Q and n. The values of A and R, and the elevations of the water surface at the three cross-sections are known. Table II shows the values of the various factors corresponding to trial values of Q. Column 7 shows the relationship between n and s at each cross-section for the various trial values of Q, and depends only on the trial value of Q and the data of Table I as related in the Manning formula. In Col. 5 is given the average slope, between adjacent cross-sections, of the trial energy gradient fixed by the data in Col. 4, and Col. 6 is found by substituting Col. 5 in the Manning formula, Eq. 1.

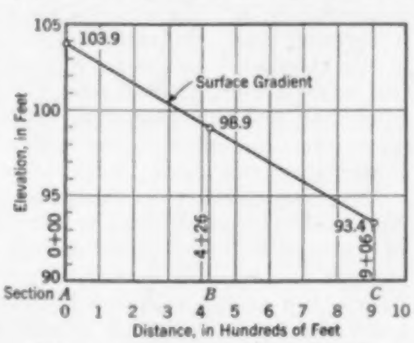


FIG. 1. PROFILE FOR GLEN CREEK (NEW YORK) FLOOD

TABLE II. VALUES OF n AND s FOR TRIAL VALUES OF Q

Trial Q (Cu Ft per Sec)	(1) Section	(2) V	(3) $\frac{V^2}{2g}$	(4) El. of Energy Gradient	(5) Average s	(6) Average n	(7) $n/s^{1/2}$	(8) n	(9) s
10,000	A	7.3	0.82	104.72			1.135	0.109	0.0092
					0.01083	0.104			
	B	8.8	1.20	100.10			0.885	0.099	0.0125
								0.082	0.0086
					0.01202	0.103			
	C	7.7	0.93	94.33			0.998	0.124	0.0154
12,000	A	8.7	1.18	105.08			0.953	0.088	0.0085
					0.01044	0.085			
	B	10.6	1.73	100.63			0.735	0.082	0.0124
								0.065	0.0078
					0.01226	0.086			
	C	9.3	1.34	94.74			0.826	0.107	0.0167
13,000	A	9.5	1.39	105.29			0.874	0.083	0.0090
					0.01022	0.078			
	B	11.4	2.03	100.93			0.683	0.073	0.0114
								0.058	0.0072
					0.01240	0.080			
	C	10.0	1.57	94.97			0.769	0.102	0.0176
15,000	A	10.9	1.84	105.74			0.760	0.071	0.0087
					0.00971	0.066			
	B	13.2	2.70	101.60			0.590	0.061	0.0107
								0.052	0.0078
					0.01272	0.070			
	C	11.6	2.09	95.49			0.662	0.088	0.0176
20,000	A	14.5	3.27	107.17			0.572	0.046	0.0064
					0.00814	0.045			
	B	17.6	4.80	103.70			0 442	0.044	0.0099
								0.049	0.0123
					0.01370	0.055			
	C	15.5	3.72	97.12			0.496	0.061	0.0151
25,000	A	18.2	5.12	109.02			0.456	0.031	0.0046
					0.00615	0.031			
	B	22.0	7.50	106.40			0.354	0.031	0.0077
								0.041	0.0135
					0.01500	0.046			
	C	19.3	5.80	99.20			0.398	0.051	0.0165
30,000	A	21.8	7.37	111.27			0.380	0.020	0.0028
					0.00369	0.020			
	B	26.4	10.80	109.70			0.294	0.020	0.0046
								0.035	0.0143
					0.01660	0.040			
	C	23.2	8.33	101.73			0.331	0.045	0.0185

To determine the values of n and s at the three stations (Cols. 8 and 9), which will be consistent with the averages given in Cols. 5 and 6, there are available the system of equations comprising Col. 7 ($n_A = 1.135\ s_A^{1/2}$, $n_B = 0.885\ s_B^{1/2}, \ldots$) and the equations relating the averages in Cols. 5 and 6 to the arithmetical averages of n and s at adjacent stations. For example, for $Q = 20{,}000$, given the data in Cols. 1 to 7, inclusive, find n_A, n_B, n_C, s_A, s_B, and s_C as recorded in Cols. 8 and 9.

$$\left.\begin{aligned} &\text{From Col. 7,} && n_A = 0.572 s_A^{1/2},\ n_B = 0.442 s_B^{1/2} \\ &\text{From Cols. 5 and 6,} && \frac{n_A + n_B}{2} = 0.045,\ \frac{s_A + s_B}{2} = 0.00814 \end{aligned}\right\} \quad (2)$$

$$\left.\begin{aligned} &\text{From Col. 7,} && n_B = 0.442 s_B^{1/2},\ n_C = 0.496 s_C^{1/2} \\ &\text{From Cols. 5 and 6,} && \frac{n_B + n_C}{2} = 0.055,\ \frac{s_B + s_C}{2} = 0.01370 \end{aligned}\right\} \quad (3)$$

Equations 2 are easily solved and lead to the double values:

$$n_A = 0.046,\ 0.066;\quad s_A = 0.00644,\ 0.0133$$
$$n_B = 0.044,\ 0.024;\quad s_B = 0.00990,\ 0.00294$$

However, Eqs. 3 lead to single values:

$$n_B = 0.049;\quad s_B = 0.0122$$
$$n_C = 0.061;\quad s_C = 0.0051$$

Single values occur in solving Eqs. 3 because the particular quantities are such that the radical becomes practically zero in the solution of the quadratic for n_B.

In general, double values result for the solution of the four equations obtained between the quantities at two adjacent stations, as with Eqs. 2, but experience indicates that with only five or six trial values of Q there will be enough single-valued exceptions to guide the final solution. The double values (not shown in Cols 8 and 9) are

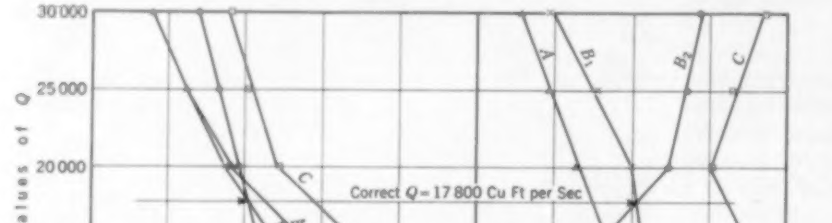


Fig. 2. Variations in n and s with Assumed Values of Q
Data from Cols. 8 and 9, Table II

retained until the equations are solved for the entire series of Q values.

The values to be retained and entered in Cols. 8 and 9 are then determined by plotting the results as in Fig. 2 and observing the following general considerations:

1. The average n for successive intervals, AB, BC, ... decreases regularly as the assumed Q increases (Col. 6).
2. The average s for AB (Col. 5) decreases as Q increases, for BC increases as Q increases.
3. Graphs (Fig. 2) showing the variation of n and s with Q for A and B_1, and for B_2 and C, must show a regularity and slope corresponding to the features noted in Eqs. 1 and 2 for the intervals AB and BC.
4. The controlling values are those introduced by the single-valued solutions such as obtained with Eqs. 3.
5. For the common cross-section, B, the two graphs (Fig. 2) for n and s should show intersection at a common value of Q.

For the correct Q, there will be but one value of n and one of s at an intermediate station, B, whether the solution be found from equations relating the quantities at the adjacent station on the one side or on the other. Thus, in Fig. 2, line B_1 indicates values of n_B or s_B obtained with Eqs. 2 between A and B, and line B_2 indicates values of n_B or s_B obtained with Eqs. 3. The intersections of these lines must signify the correct value of Q—in this instance, 17,800 cu ft per sec.

After Q has been thus determined, a check should be made by introducing the selected Q at the several stations; calculating A, R, V, $\frac{V^2}{2g}$ and the elevation of the energy gradient; using the new values of n_A, n_B, n_C, s_A, s_B, s_C; and comparing the calculated energy drop with the difference between energy gradient elevations.

The value of 17,800 cu ft per sec for Q contrasts with 27,900 obtained by usual methods. The difference of 10,100 cu ft per sec is nearly 57% of the value computed by the writer's method. Published records of flood flows computed by the slope-area method that have been checked by the writer appear to be from 20 to 60% higher than justified by the circumstances. This difference is no doubt attributable (1) to the assumption inherent in the larger figure that s in the Manning formula is equivalent to surface slope and, (2) to the usual procedure of estimating n from general considerations.

The data used in the example apply to a stream having 21.3 sq miles of drainage area. The preceding values of Q correspond, respectively, to discharges of 835 and 1,310 cu ft per sec per sq mile.

A minimum of three cross-sections is necessary to any solution. The example taken to illustrate the method of computation gives more clean-cut results than can be expected when the circumstances are complicated by backwater effects from obstructions lodged in the stream channel. Data for a more complicated circumstance should include a survey of a longer stretch of river and several more cross-sections. The number of intermediate cross-sections which furnish independent determinations of Q is 2 less than the total number of sections. The correct value of Q can be considered the average of the several independently computed values.

When the circumstances are complicated by a series of washed-out bridges destroyed at various times during a flood, there are local surges of discharge and backwater as various obstructions let go and lodge again farther downstream. The survey of field data undertaken after subsidence of flood conditions naturally seeks to record the highest stages of which there is reliable evidence along the river reach under investigation. Analysis of the data will doubtless show differences in the value of Q determined independently for each of the intermediate cross-sections. The practical method of averaging the results will give a Q which correctly represents average circumstances during the flood period.

Accurate Determination of n Important

The factor n is referred to as the "coefficient of roughness," a misnomer in the writer's opinion; it is really a "coefficient of circumstances." This one factor includes all the features of river flow not physically measurable or clearly understood. It is likely that the value of n depends chiefly on the area of water contact with the bottom and sides of the river channel, which for a unit of channel length is defined as wetted perimeter. When open-channel discharge conditions prevail, there seems to be a determinable relationship between n and wetted perimeter. So far as the writer's experience goes, no such relationship is apparent in the presence of backwater effect from obstructions washed into the river channel—that is, identical values of n may occur at cross-sections having different values of wetted perimeter. Possibly what is needed for a better understanding of the factor n in hydraulic formulas is a breakdown of this factor into two or three component parts, each representing a distinctive characteristic.

The practical value of an accurate determination of n and its variation along the river reach is to indicate the approximate location where river improvement may be undertaken most profitably to increase the flood capacity of the channel. An assumed value of n cannot contribute to an accurate conclusion. The factor n should be calculated just as is any other important factor affecting an engineering solution, and it almost invariably proves higher than the value likely to be assumed.

The error inherent in assuming the friction slope s as equivalent to surface slope is not important if the values of average velocity from section to section are low enough to result in small differences in velocity-head values, but as the value of V at any section cannot be known until the value of Q has been determined, the distinction between friction slope and surface slope should be preserved.

Inexpensive Structural Models

Convenient Construction Solves Rigid-Frame Problems, Aids "Feeling" for Deflections

By WILLIAM J. ENEY, ASSOC. M. AM. SOC. C.E.
ASSISTANT PROFESSOR OF CIVIL ENGINEERING, LEHIGH UNIVERSITY, BETHLEHEM, PA.

AN interesting use of structural models is the demonstration of deflection changes. In the August 1940 issue of CIVIL ENGINEERING, Kenneth W. Dowie has described a model rigid frame employed in this way. It may be of interest to describe similar inexpensive devices used at Lehigh University.

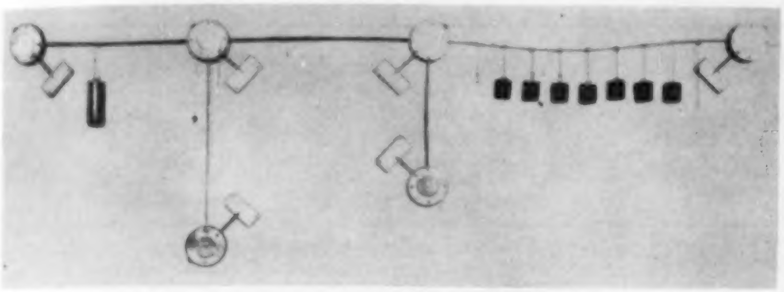


FIG. 1. BRASS JOINT "LOCKS" AND STEEL DRILL-ROD FRAMES DEMONSTRATE HARDY CROSS PROCEDURE

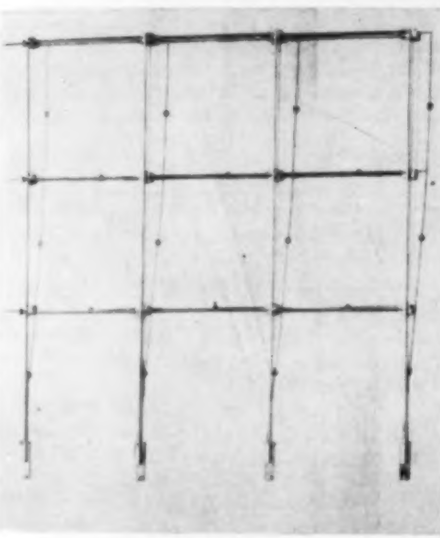


FIG. 2. BUILDING FRAME WITH WIND LOADS
Circles Indicate Inflection Points

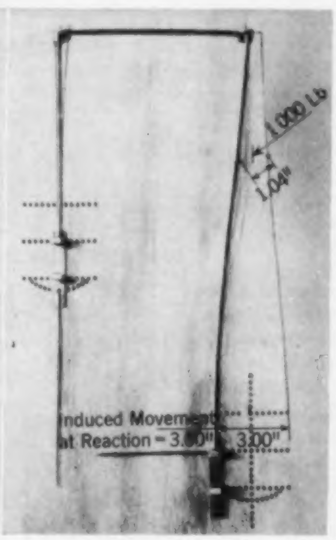


FIG. 3. HORIZONTAL REACTION OF A FIXED-END FRAME

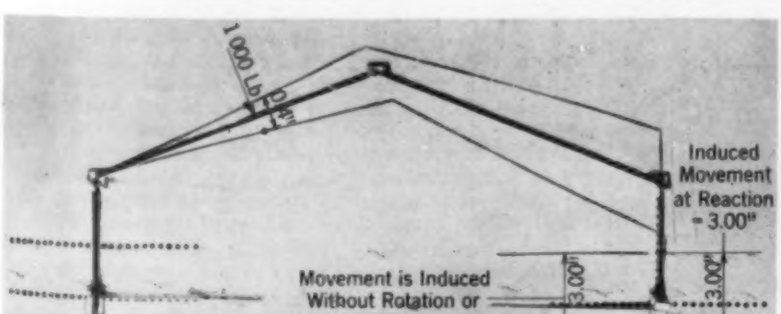


FIG. 4. VERTICAL REACTION OF A FIXED-END MILL BUILDING FRAME

The first of these, a demonstration model for rigid-frame theory, Fig. 1, is used to show the steps in the Hardy Cross method of distributing fixed-end moments. Essentially it consists of an arrangement of brass posts securely fastened to a baseboard about which brass rings are fitted. Pieces of heat-treated steel drill rod fitted into holes in these rings form the members of the frames. In demonstrating the moment distribution process, the joints are locked against rotation by clamping the rings to the posts; weights are hung on the members; and then the joints are successively unlocked. If the posts and rings are carefully fitted to avoid friction and the drill rods equally well fitted to allow them to slip in and out of the rings, quantitative as well as qualitative results can be obtained. Complete details of the construction and further uses of the device are described in *Newark Engineering Notes* for March 1940, by William S. La Londe, Jr., M. Am. Soc. C.E., originator of the idea.

The second type of model used at Lehigh is made from leaded brass drill rod (Figs. 2, 3, and 4). Its cost is negligible and anyone able to solder can make it. In Fig. 2 it is being used to demonstrate the location of the inflection points in a building frame subjected to wind forces. Similar models representing an irregular or unsymmetrical arrangement of columns and girders with or without knee braces will vividly illustrate the shift in inflection points.

A model of a kind of frame frequently met with in practice appears in Fig. 3. This and similar brass models were made by students who had never before used a soldering iron. When the models had been loaded to show the inflection points, influence lines for reactions were determined by displacing the model as shown, in the manner developed by the late George E. Beggs, M. Am. Soc. C.E. For instance, in Fig. 3 the right horizontal reaction of the fixed frame for an inclined 1,000-lb load was obtained by displacing the right support 3 in. horizontally without rotation or vertical displacement. A pattern of holes drilled in a drawing board with the aid of a template, together with an indicator arm and closely fitting pins cut from a steel drill rod, is used to introduce this displacement in the desired manner. For example, the deflection of the model at the load point was recorded as 1.04 in. By Maxwell's reciprocal theorem, the right reaction is then $\frac{1.04 \text{ in.}}{3.00 \text{ in.}} \times 1{,}000 \text{ lb} = 347 \text{ lb}$. The vertical reaction was determined in a similar manner, as illustrated in Fig. 4.

When such models are used to check analytical solutions of frames and then

modified to introduce knee braces, fillets, stiffened or rearranged members, the observer after a few minutes of handling develops considerable judgment as to the structural action of such frames and attacks the design with greater understanding. Three-dimensional models of frames and trusses easily assembled in brass at very little cost illustrate the interaction of floor systems and lateral bracing in an effective manner.

The construction and use of brass wire models have been described by the originator, Anders Bull, M. Am. Soc. C.E., both in CIVIL ENGINEERING (August 1937, page 561) and elsewhere. During the past several years the writer has made frequent use of such models to good advantage, and he urges the young structural engineer to consider them when he pursues further study after graduation.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Analysis of Soil Bearing Tests

TO THE EDITOR: The article on "Practical Shear Tests for Foundation Design," by Trent R. Dames, in the December issue, prompts me to write of the results of soil bearing tests I conducted at Kansas City, Kans., in 1939.

The soil at test No. 1 consisted of a very moist blue river silt, containing some very fine sand and streaks of humus material. The soil at test No. 2 consisted of a damp, clean, medium, yellow sand, which was fairly well compacted.

Tests were made by loading 2 by 2-ft concrete footing blocks cast in place in increments of 1,000 lb per sq ft. Readings were taken before, immediately after, 12 hours after, and 24 hours after applying each increment of loading.

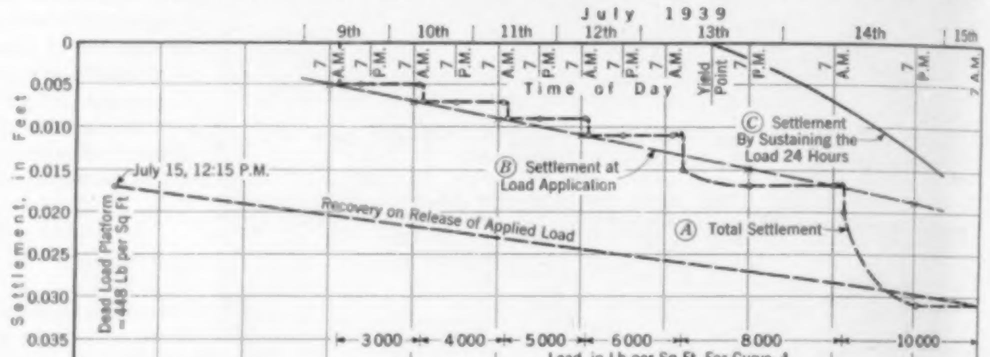


FIG. 2

On the accompanying diagrams (Figs. 1 and 2) Curve A shows the accumulated total settlement during the progress of each test. Two distinct types of settlement are apparent—that which occurred quickly upon application of each increment of load, and that which occurred very slowly during the 24-hour period in which the footing was sustaining the total load. Curve B was plotted by taking the amounts of settlement that occurred at each load application and accumulating them. In a similar manner, Curve C was plotted by accumulating that portion of the total settlements that occurred during each of the 24-hour periods the total loads were being sustained. By producing Curve C back to zero settlement, a well-defined "yield point" of the soil is determined.

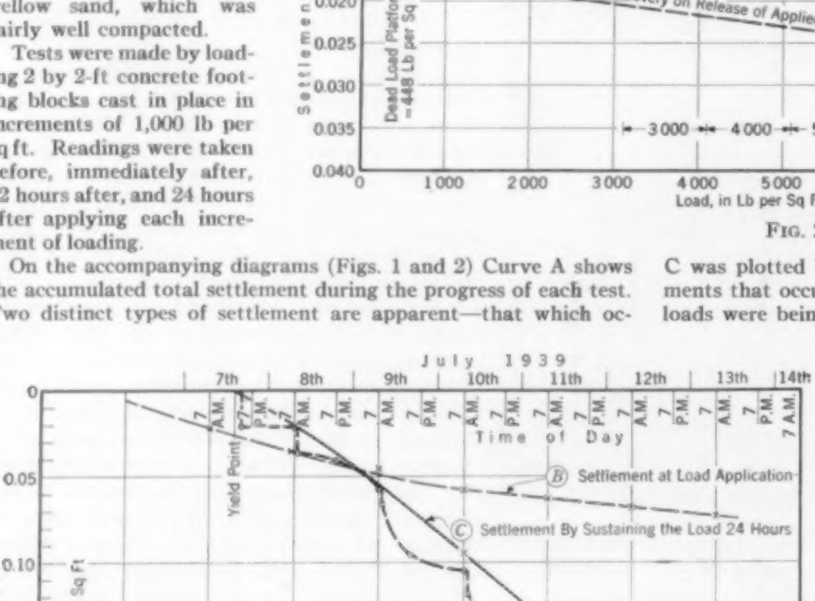


FIG. 1

In the case of test No. 2, the yield point is about 7,500 lb per sq ft. A factor of safety of about 2 would give a safe design load of about 3,800 lb per sq ft for this soil. Engineers in the district in which these tests were made consider 4,000 lb per sq ft as the safe allowable design load. At 4,000 lb per sq ft, a settlement of 0.007 ft can be expected, as indicated by Curve B, but no further settlement should occur.

In the case of test No. 1, the yield point is about 2,300 lb per sq ft. A factor of safety of about 2 would give a safe design load of only about 1,200 lb per sq ft for the soil at this location. At 1,200 lb per sq ft, a settlement of 0.008 ft can be expected, as indicated by Curve B, but no further settlement should occur.

On completion of the tests the loads were removed to determine the amount of elastic recovery. On both of these tests, the respective amounts of elastic recovery are equal to the settlement on Curve B under the "yield point." I have not been able to attach any significance to this fact. It would be interesting to measure the elastic recovery at each loading point and to compare its curve with the others.

The location of the intersection of Curve B and Curve C may be an indication of the physical properties of the soil.

The results of the two tests lead me to believe that a larger number of tests, conducted in a standard manner, should produce interesting and valuable information, establish the reliability of the method, and more definitely determine the relation that might exist between shear tests and allowable loads on soils. If a definite relation does exist, it might be possible to determine allowable soil loads for foundation design by relatively simple laboratory tests, to a precision similar to these actual loading tests.

S. B. May
St. Louis, Mo. *Consulting Engineer*

Earth Pressures in Cohesive Soils

Dear Sir: In Mr. Feld's article, "Applications of Soil Mechanics in the Heavy Construction Industry," in the April issue, an illustration is given of the failure of a bank of earth beside a trench which was excavated to the level of an old sewer. The excavation was not braced, and failure occurred when the top of the old sewer was removed. This accident has been used by Mr. Feld on several occasions to demonstrate the error of certain "recent" theories of earth pressure which postulate that the greatest pressure acts near the upper part of an excavation. Within the writer's knowledge this statement has gone unchallenged, although it appears to involve fundamental misconceptions regarding the nature of the earth pressure problem in cohesive soil. So far as the writer is aware, there is no theory of earth pressures for cohesive soil, either classical or "recent," which does not state that if the depth of a cut is increased without the addition of bracing, the factor of safety of the sides of the cut against failure is decreased. This appears to have been the case in Mr. Feld's illustration. Removal of the arch of the existing sewer had the effect of increasing the depth of the excavation.

It should also be pointed out that in an unbraced excavation the question of distribution of pressure has no significance because it is obvious that there is no lateral pressure at any elevation above the bottom of the cut. This is simply a matter of statics.

The "recent" earth pressure theories which postulate the existence of the center of pressure at a point above the lower one-third of the height of the cut are all based upon the assumption that the lateral squeeze of the cut is restricted in the upper portion. This restriction requires the presence of struts. Mr. Feld's intimation that a high center of pressure is a modern conception is not borne out by a quotation from the eminent excavation engineer, J. C. Meem, who in 1908 stated "that all closely sheeted well-braced trenches invariably show a heavier pressure at the top than at the bottom."

R. B. Peck, Jun. Am. Soc. C.E.
Assistant Subway Engineer, Department of
Chicago, Ill. *Subways and Superhighways*

Sludge Handling Costs

Dear Sir: In his article on the "New Sewage Treatment Plant at Anderson, Ind.," in the May issue, Mr. Poole states, "The high inorganic content of the sludge cake was unexpected and is undoubtedly responsible for throwing the sludge handling costs out of balance with similar installations." He also indicates that this inorganic content is largely due to the presence of clay.

Although high mineral content in any sludge is responsible for increased incineration costs, I cannot agree that the same statement applies to increasing sludge-conditioning costs.

The net effect of mineral or inorganic matter in any sludge is to reduce the amount of volatile or organic matter present and to increase the specific gravity, stable structure, and amount of solids. These effects automatically diminish the amount of sludge-coagulating chemicals necessary for proper vacuum filter yields. If the suspended sludge solids were entirely mineral, they would not decompose. Furthermore, they would require no digestion, no coagulation for dewatering, and no incineration. The net effect of organic or volatile matter is just the opposite. The higher the percentage of volatile matter present, the lower becomes the specific gravity of the solids and the greater the residual moisture in the sludge and the concentration of biochemical decomposition products in the moisture per pound of sludge solids during storage and sludge digestion. In the digestion of the type of sludge obtained at Anderson the sludge moisture becomes materially loaded with ammonium bicarbonate and other biochemical reagents that react with ferric chloride and lime.

For example, if the alkalinity of the digested sludge liquor at Anderson is assumed to be but 3,500 ppm, this amounts to 0.062 lb of alkalinity per pound of digested solids according to Mr. Poole's Table II, wherein the digested sludge solids average 5.35%. This means that there are 17.7 lb of sludge liquor present per pound of solids. This alone would account for a large proportion of the sludge-conditioning chemicals used (see Paul D. McNamee in *Sewage Works Journal* for September 1939, page 764).

According to Mr. Poole's Table II the digested sludge going to the filters averaged 45% volatile. This is not at all out of line with a number of installations digesting sludge from combined sewage, where considerably lower conditioning costs prevail. In the January 1941 issue of Proceedings (pages 72 and 77) George J. Schroepfer, Assoc. M. Am. Soc. C.E., shows the effects of mineral matter in the raw sludge at Minneapolis–St. Paul, and in the November 1939 issue of the *Sewage Works Journal* (page 988) C. R. Velzy, M. Am. Soc. C.E., shows similar effects with the digested sludge at Buffalo. The table also shows that the filter cake averages 13% less volatile solids than does the "Sludge to Filter." This is largely due to the use of lime and amounts to adding more ash to something one desires to make more combustible.

In my opinion the digested sludge at Anderson is excellently suited to elutriation treatment prior to conditioning. This will materially diminish the natural reagents accumulated in the sludge moisture and eliminate the use of lime. According to Mr. Poole's Table III, the average costs at Anderson per million gallons sewage treated were $3.85 for sludge conditioning and $3 for fuel oil for incineration, making a total of $6.85. Elutriation properly applied here will save over 60% of sludge-conditioning costs and 13% of the fuel oil costs. The inorganic content of the sludge will then become an asset in cutting conditioning costs and less of a liability in incineration.

A. L. Genter, M. Am. Soc. C.E.
Baltimore, Md. *Consulting Engineer*

Manning's *n*

To the Editor: The discussion aroused by my attempt to correlate Manning's *n* with Reynolds **R** and Darcy's *f* (February issue of Civil Engineering) has been enlightening to me. I appreciate the interest taken in my paper. Dr. Rouse's criticism of my Eq. 3 (see his discussion in the March issue) indicates that it is confusing. The **R** should have been given some other symbol to indicate that it is a special parameter devised for the sole purpose of solving Eq. 2 graphically.

For one who is trying to utilize a background of familiarity with Manning's *n* to implement his judgment in the less familiar **R,** I know of no alternative to using Eqs. 1 and 2. The nomogram is merely a graphical solution.

The conclusion of the matter is, apparently, that while Manning's *n* is not functionally related to these other factors, as Mr. Kalinske states in the March issue, it will correlate in wide reaches of velocity and roughness.

In the June issue Professor Powell points out some of the conditions under which it fails, particularly in hydraulic models.

Denver, Colo. Robert E. Kennedy, M. Am. Soc. C.E.

Draining Military Air Fields

To the Editor: I was deeply interested in Captain Newton's article, in the April issue, entitled "Construction of Military Air Fields," particularly with reference to drainage practice and drainage structures.

The dearth of information and wide variation in opinion respecting impact of landing airplanes are indicated in the notation under Captain Newton's Fig. 1, which states "Grating is designed to carry wheel load of 32,500 lb plus 50% impact." As a matter of fact, the impact of landing airplanes is of less consequence to drainage structures than is the static load of planes at rest.

R. A. Hart, M. Am. Soc. C.E.
Special Engineer, Interstate Brick Company
Salt Lake City, Utah

Time Required for Saturation of Earth Embankment

To the Editor: The time required for saturation of an earth embankment is discussed in an article by K. P. Karpoff in the April issue. The derivation of the equation,

$$q = vy = -ky\frac{dy}{dx} \quad \text{.....................} (1)$$

depends upon Dupuit's assumption that the velocity is the same at all points lying on any vertical line through the section. Integration of Eq. 1 yields,

$$\frac{qx}{k} = -\frac{1}{2}y^2 + C \quad \text{.....................} (2)$$

Equation 2 must satisfy more boundary conditions than Mr. Karpoff mentions. These are, at $x = 0$, $y = h$; and at $x = s$, $y = a_0$ and $\frac{dy}{dx} = \tan\phi$

and are compatible with Eq. 2, providing

$$\frac{1}{2}h^2 = \frac{qs}{k} + \frac{1}{2}a_0^2$$

and,

$$q = ka_0 \tan\phi$$

These conditions are sufficient to determine q, a_0, and the position of the line of saturation and will approximate the actual condition if the flow lines are essentially horizontal. When the downstream face slopes more than about 30 deg, or when discharge is into an overhanging, free-draining rock toe (for which case the slope at discharge must be vertical) Darcy's formula should be written more exactly, $v = -k\frac{dy}{ds}$.

In an article entitled "Seepage Through Dams" (*Journal of the New England Water Works Association*, June 1937) Dr. Arthur Casagrande discusses the solution of both these problems.

Mr. Karpoff presents the formula,

$$\text{Time for saturation} = \frac{L^2}{2kh'\cos\phi} \quad \text{.............} (3)$$

In the case of the overhanging or vertical discharge slope ϕ becomes equal to 90 deg, for which Mr. Karpoff's formula gives an infinite time of saturation.

The writer had some trouble following Mr. Karpoff's reasoning in deriving his formula and still doubts the validity of some of his assumptions. Mr. Karpoff states that U, the velocity at M, is equal to $k\frac{h'}{x}$. Apparently he intended this equation to define the velocity at x of a particle at the boundary of the saturated portion as it travels downstream, instead of the terminal velocity at M as stated. Considering the condition at the point where the line of saturation intersects the downstream slope after sufficient time has elapsed for final saturation to occur,

$$dl\,\Big|_{x\,=\,L}^{t\,>\,\text{time for saturation}} = \frac{dx}{\cos\phi} \quad \text{...............} (4)$$

and since, $dt = \frac{dl}{U}$

Mr. Karpoff determines by substitution,

$$dt = \frac{x\,dx}{kh'\cos\phi} \quad \text{.....................} (5)$$

The differential Eq. 5 is true only at the final point in the interval, where $x = L$ and after saturation has occurred. Mr. Karpoff, however, integrates between the limits $t = 0$ to t = time for saturation and $x = 0$ to $x = L$.

Dean F. Peterson, Jr., Jun. Am. Soc. C.E.
Project Engineer, Savage River Dam

Western Port, Md.

Trough Coefficients Explained

To the Editor: There is an interesting agreement (possibly the reader will regard it as accidental) between the formula developed by Messrs. Dewante and Stowell in their article, "Flow in Effluent Troughs," which appeared in the April issue of Civil Engineering, and the earlier one of C. N. Miller (mentioned by the authors), which was intended for non-free fall conditions.

Assuming in the latter case that the critical flow condition exists at the lower end of the trough—where depth equals twice the velocity head—it is easy to show that the Miller formula implies a total drop in water surface from the upper end of the trough of 2.13 velocity heads or $0.516y$ where y, as the authors explain, is the vertical distance from the upstream water surface in the trough to its downstream lip.

Now let it be supposed, as seems plausible to the writer, that the effect of changing from the non-free fall condition to the free fall condition is to increase the effective head causing flow of the stream at the outlet of the trough by an amount equal to half the depth of the stream at this point—namely, $\frac{1}{3}(y - 0.516y) = 0.242y$, or from $0.516y$ to $0.758y$. Also, let it be assumed that the outlet depth is unchanged (this seems to be less plausible). The effect, then, of the change from non-free fall to free fall condition is to change the capacity by a factor equal to $\sqrt{0.758/0.516} = 1.213$. This when applied to the Miller expression for Q, $1.91y^{3/2}$, makes it become $2.32y^{3/2}$, which is precisely the author's expression for Q.

W. E. Howland, Assoc. M. Am. Soc. C.E.
Associate Professor of Sanitary Engineering, Purdue University

Lafayette, Ind.

A Buck Private Reports

To the Editor: The Piedmont section of South Carolina is colorful with its green pines, red clay, and sunny skies, but to a soldier at Camp Croft it is a dustridden, devilishly hot place. Surprisingly though, the boys all seem to like it, and I am rapidly finding that being in the Infantry has many interesting features.

I must admit that, at first, I was sorely disappointed at failing to be placed in the Engineers', even though I knew that being a buck private there meant pick and shovel rather than transit and range pole. I still have hopes that at the end of my basic training, I can wangle a transfer into the Railroad Battalion of the Corps of Engineers.

It is almost like college here, our lectures being given in any convenient pine-shaded arena and theory put immediately into practice. Cleaning the ubiquitous red dust out of the so many hiding places about our rifles comprises our daily homework. We spent last week on the rifle range, most of us shooting our Springfields for the first time in our lives. After the preliminary flinching we began to enjoy it. Shooting for record at the end of the week, I surprised myself by qualifying as marksman, and close enough to the sharpshooter category to look forward to the next time. It was a well-filled week—reveille being at 4:15 a.m. The 3½-mile march to the range started just at sunrise, and the tired return home was at nightfall. And many were the black eyes, the smashed lips, the sore backs!

The people here are extremely friendly to us. The sizable city of Spartanburg is but 7 miles away, and many townspeople have invited trainees to Sunday dinner and for motor rides. The other day I had the pleasure of talking to a surveying party from the Southern Railway, which was rerunning the center-line of a branch line just outside the camp. Army life is an extremely healthful, pleasant one, but my first love will always be engineering, and I anxiously await my return to the Pennsylvania Railroad. None of us know just where we go when our 13-week period ends here July 1; the rumors are plentiful, of course.

The 13,000 boys now here come from New York, New Jersey, Illinois, Wisconsin, Georgia, Maryland, Pennsylvania, and Massachusetts, so that the accents are many and the interchange of talk a happy pastime.

I am afraid I have a bit of sewing to do, so good-bye for now. Let's hope that America keeps a level head about it—war isn't very practical.

Camp Croft, S.C. John D. Hanft, Jun. Am. Soc. C.E.

Time Involved in Saturating Earth Dams

Dear Sir: With reference to Mr. Karpoff's article, in the April issue, on "Time Required to Saturate an Earth Dam," it should be noted that while the formulas developed from the original Dupuit assumptions for gravity flow have given results that check very closely with those obtained by experiment for certain steady flow conditions, the application of these equations to transient conditions has heretofore never been checked.

The writer has made investigation at the University of California with reference to the periodic fluctuating flow through porous media and has found that the application of these equations is not feasible because of the magnitude of the errors involved in the original Dupuit assumptions. Specifically, Dupuit assumed that for small inclinations of the free surface in gravity-flow systems the streamlines may be taken as horizontal and are to be associated with velocities which are proportional to the slope of the free surface but are independent of the depth.

In his book, *Flow of Homogeneous Fluids Through Porous Media*, H. Muskat discusses the effect of these assumptions for steady flow and points out that since it is assumed that the vertical velocity remains uniform in a horizontal plane, at a boundary of uniform potential the vertical velocity is zero and therefore the vertical velocity must vanish throughout the system. If the vertical velocity vanishes, the free surface must be horizontal, which is contrary to the characteristics of gravity flow. Also at the inflow face, where the slope of the free surface is zero, the velocity distribution is far from uniform and the average velocity has no relation to the slope of the free surface. These discrepancies have been found to be much greater at the outflow face where there is a definite discontinuity—the percolating water flows into a region which is free of both porous media and water but is exposed to atmospheric pressure. With appreciable vertical velocities the pressure distribution over vertical sections is not hydrostatic. These facts in no way lessen the importance of the solutions which have been based on the Dupuit assumptions, but indicate the caution with which they must be applied. In regions where the slope of the free surface is small they may be applied in order to give the total flux with remarkable accuracy.

The writer in his study of periodic fluctuating flow through porous media found by measurement that at times the vertical velocity amounted to 500 times the horizontal velocity. All attempts at predicting the time rate of change of the free surface based on the Dupuit assumptions proved futile. It was found that within the range of the experiments empirical equations could be written, which expressed quite well the experimental data for the time rate of change. Because of their empirical nature no attempt was made to extrapolate the results to apply to full-scale structures.

Of practical importance, also, is the water in the voids above the line of saturation, which will be under the influence of gravity and cause flow in both vertical and horizontal directions tending to fill the air voids below the line of saturation before there is water behind the dam. With tight soils there is in general a tendency for part of the voids to contain entrapped air which never escapes, the water percolating around them. If those voids amounted to 0.7% in the case cited by Mr. Karpoff, seepage would commence immediately with the application of water behind the dam. The time it takes to saturate the dam is, also, a definite function of the time rate of rise of the water behind the dam. Since in practice this time is appreciable it cannot very well be neglected in determining the time it takes to saturate the dam. In practice, also, the effects of capillarity cannot be neglected, a phenomenon in itself being a function of time.

The practical importance of being able to predict the time variation of the free surface cannot be overestimated, but any attempts to apply the Dupuit assumptions should be checked by actual experiment before predictions are made.

Robert C. Miller
Captain, Corps of Engineers
U.S. Army

Berkeley, Calif.

Comments on "Four Regimes of Open-Channel Flow"

Dear Sir: I wish to comment on the article entitled "On the Four Regimes of Open-Channel Flow" by Messrs. Robertson and Rouse in the March issue.

In explaining the photographs shown in their Fig. 2, the authors state "The fourth possible case—that of tranquil-turbulent flow—is not illustrated, because it could not be obtained with the slope chosen . . ." It appears to me in studying the photographs that the right-hand side of Fig. 2 (*c*) represented the case in question—namely, that of "tranquil-turbulent" flow. In this case the water slope is controlling rather than the bottom slope of the channel.

From the flow relations before and after a hydraulic jump of $Y_1V_1 = Y_2V_2 = \nu R$ for a wide shallow channel, it is evident that conjugate depths of flow before and after a jump have the same Reynolds number. According to the authors' Fig. 1, a flow in Zone 2 passing through a jump will have a conjugate depth in Zone 1, and a flow in Zone 4 passing through a jump will have a conjugate depth in Zone 3.

Therefore, in the photographs shown in Fig. 2, regimes of flow are illustrated as follows: The left-hand sides of the photographs *a*, *b*, and *c* represent, as stated by the authors, flows in Zone 1, Zone 2, and Zone 4, respectively; while the right sides of the photographs represent flows in Zone 1, Zone 1, and Zone 3, respectively,

To identify flow in the right side of Fig. 2 (*b*) by visual inspection alone would probably lead one to an erroneous conclusion, even though the dispersion of the dye by the jump is not complete. However, a jump is always accompanied by energy loss which must come about by turbulence. Therefore, although the flow is in the tranquil-laminar range it is turbulent in manner. The authors make the comment that investigators sometimes fail to recognize laminar flow. The article is clarifying with regard to identification of flow in hydraulic model study.

J. V. Spielman, Assoc. M. Am. Soc. C.E.

San Marino, Calif.

Planning for Multiple-Purpose Water Projects

To the Editor: The article by Nicholls W. Bowden, in the May issue, and that by E. B. Debler, in the February issue, discuss a very important trend in water conservation or, perhaps more properly, water utilization planning in the United States. Certainly when plans are being made much is to be gained by considering all possible uses—irrigation, water power, and navigation—as well as dangers such as soil erosion and floods, of the water supply in a basin.

While the plans for Western irrigation projects have only recently included definite flood control provisions, it has been customary for many years for the managers of such projects to operate the storage reservoirs with some consideration of flood control possibilities. In recent years this procedure has been greatly encouraged by the expansion and coordination of the snow survey and irrigation water forecast program, in which the Division of Irrigation of the U.S. Soil Conservation Service is cooperating with interested state, federal, and local water-using agencies. This program, authorized by Congress in 1935, is active in all the Western states and has rendered much service to the irrigation farmers and other users of water from streams having their principal source in the mountain snows. As the records accumulate and are analyzed, they will make even more accurate forecasts possible. As a result the type of operation discussed by Mr. Bowden will be carried on with much greater assurance of safety from unexpected floods, much greater utilization of reservoir space for storage purposes, or with both.

M. R. Lewis, M. Am. Soc. C.E.
Senior Agricultural Engineer,
Soil Conservation Service
U.S. Department of Agriculture and
Oregon Agricultural Experiment Station

Corvallis, Ore.

Cantilever Poles in Sandy Soils

TO THE EDITOR: In the May issue Prof. Robert W. Abbett writes on the "Stability of Cantilever Poles in Sandy Soils."

On the basis of the author's statements that, "The resistance to rotation at the instant of impending motion comprises the forces of friction and cohesion acting on the surface of the cone. The resultant of these forces normal to the pole, therefore, must be proportional to the surface area of the cone. . ." the conclusion would be reached that the total force resisting overturning is proportional to the square of the depth of embedment, d (see the accompanying Fig. 1). The maximum passive resistance must then vary linearly with the depth below the ground surface and not as the square of that distance (Fig. 2 (*a*)). On the basis of this linear variation and using a method of procedure similar to that given by Professor Abbett, the following equations are derived: $k = \frac{3d + 4h}{4d + 6h}$, $d = \sqrt[3]{\frac{Ph}{ec.}\,\frac{12k}{3-4k}}$.

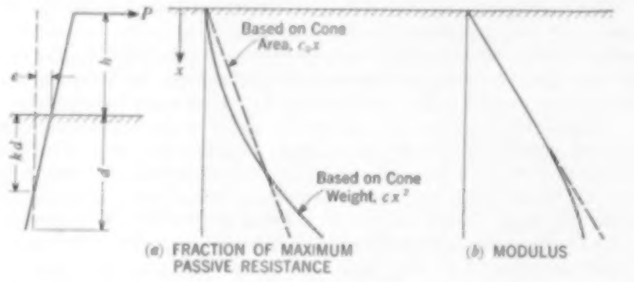


FIG. 1. FIG. 2. DEPTH VARIATION OF SOIL PROPERTIES

Inspection of the expression for k shows that, for a pole, the center of rotation is between $^2/_3$ and $^3/_4$ of the depth of embedment below the ground surface. This result is more nearly in accord with experiment than the range $^3/_4$ to $^4/_5$ found by the author. A possible reason for this will be given later.

The expression for d is simpler than the author's Eq. 4 due to taking moments about an axis in the ground surface instead of at the center of rotation. P and h are known quantities, while the author's M depends upon d and therefore is not known exactly.

These results, based on what amounts to a modulus of elasticity varying linearly with the distance below the ground surface, are no better than that basic assumption. On the basis of the weight of the cone instead of the surface area, using the same type of reasoning one would arrive at a modulus that varies as the square of the distance. However, we know that the modulus does not vary in this manner but starts off linearly and then tends to reach a constant value at great depths (Fig. 2 (*b*)).

This discrepancy, which is the fundamental point at issue, arises from the confusion of two quite different and often independent quantities—the resistance of the soil to a given deformation, that is, the modulus, at a given depth, and the maximum force the soil can withstand at that depth without completely rupturing. In stating that the pressure at any point on the embedded portion of the pole is equal to the deflection, or movement, of that point multiplied by the quantity cx^2, Professor Abbett used cx^2 as a modulus. However, cx^2 is actually only some fraction of the maximum possible passive resistance at the point. The procedure is thus comparable to using a fraction of the ultimate strength of a steel bar as Young's modulus, E, the value of which is independent of the size and practically independent of the strength of the material.

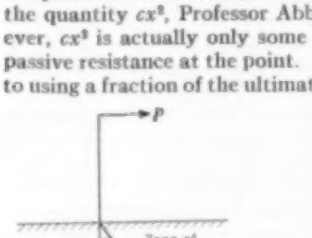


FIG. 3. DISTRIBUTION OF PRESSURE ON POLE AT LARGE SOIL DEFORMATION

In analyzing pole behavior for small deflections during which all the soil behaves almost elastically, an assumption of linear variation of modulus with depth should not be far off for small depths. This may be the reason for the agreement of the writer's computed k with experimental results.

The usual problem, however, is quite different. The question is at what load will a given pole, embedded a given amount, be pulled over. This is no longer a problem dealing with an elastic soil at low stress. Before complete failure of the soil, partial rupture will already have occurred on numerous shear planes. For some depth, the pressure in front of the pole will approximately be the maximum the soil can exert at the depth. The largest pressure will occur at the back of the pole at the bottom. Between—where the behavior of the soil is partly elastic—the pressure distribution will depend on the modulus (Fig. 3).

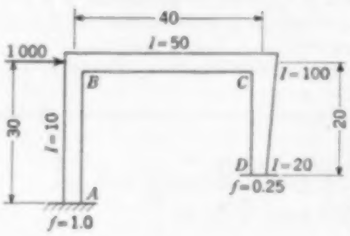
DANIEL C. DRUCKER, Jun. Am. Soc. C.E.
Instructor in Mechanics of Engineering
Cornell University
Ithaca, N.Y.

Closure of Discussion

TO THE EDITOR: The modified stiffness and carry-over factors as given in my article, "Partially Restrained Structural Members," in the February issue, are for prismatic members only. The general modifying factors for members of variable section should be $\overline{MK}_A = K_A\,[1 - (1 - f)\;\overline{CO}_{AB}\;\overline{CO}_{BA}]$ and $\overline{MCO}_{AB} = \dfrac{f\;\overline{CO}_{AB}}{1 - (1 - f)\;\overline{CO}_{AB}\;\overline{CO}_{BA}}$. This agrees with Mr. Aleck's discussion, which was published in the April issue.

The example in the accompanying Fig. 1 has been selected, because it illustrates fully the application of moment distribution to partially restrained members of variable section, and because the ease and simplicity of application and the results can be compared with those of the Stewart method (see Vol. 65 of the TRANSACTIONS of the Society, pp. 549–551).

The nominal stiffnesses, carry-over factors, and the applied sidesway moments are first determined for the members. The modified stiffness, $\overline{MK}_{CD}$, for the member CD is $13.57[1 - (1 - 0.25)(0.333)(0.745)] = 11.03$; the modified carry-over factor, $\overline{MCO}_{CD}$, is $\dfrac{0.25\ (0.333)}{1 - (1 - 0.25)\ (0.333)\ (0.745)} = 0.1025$; and the modified sidesway moments are $-1{,}810 - (1 - 0.25)\ (0.745)\ (-1{,}060) = -1{,}217.5$ and $-1{,}060\ (0.25) = -265.0$ at ends C and D, respectively. These modified values are used in the regular moment-distribution process. The moments thus obtained are then used to determine the unbalanced shear, $\dfrac{145.8 + 138.5}{30} + \dfrac{364.6 + 177.6}{20} = 36.63$. Since this unbalanced shear is to the left, the correction factor becomes $+\dfrac{1{,}000}{36.63} = +27.3$. Therefore, the final moments become $138.5\ (27.3) = 3{,}780$ at end A; $3{,}980$ at joint B; $9{,}960$ at joint C; and $4{,}850$ at end D.



$CO_{CD} = 0.333$
$CO_{DC} = 0.745$
$CO_{BA} = CO_{AB} = CO_{BC} = CO_{CB} = 0.500$
$K_{BA} = 1.333$
$K_{BC} = K_{CB} = 5.000$
$K_{CD} = 13.57$
$K_{DC} = 6.08$
Assume $\Delta = 2\,000$
$F_{AB} = F_{BA} = K_{AB}(1 + CO_{AB})\ (\frac{\Delta}{h}) = 133.6$
$F_{CD} = K_{CD}(1 + CO_{CD})\ (\frac{\Delta}{h}) = 1810.0$
$F_{DC} = K_{DC}(1 + CO_{DC})\ (\frac{\Delta}{h}) = 1060.0$

0.1025 →

AB	BA	BC	CB	CD	DC
1.333	1.333	5.000	5.000	11.03	6.08
0	0.21	0.79	0.31	0.69	0
−133.6	−133.6	0	0	−1217.5	−265.0
0	+ 28.1	+105.5	+377.5	+ 840.0	0
+ 14.0	0	+188.7	+ 52.7	0	+ 85.8
0	− 39.6	−149.1	− 16.3	− 36.4	0
− 19.8	0	− 8.2	− 74.6	0	− 3.7
0	+ 1.7	+ 6.5	+ 23.1	+ 51.5	0
+ 0.9	0	+ 11.5	+ 3.2	0	+ 5.3
0	− 2.4	− 9.1	− 1.0	− 2.2	0
−138.5	−145.8	+145.8	+364.6	−364.6	−177.6

FIG. 1. VARIABLE MOMENT OF INERTIA

W. N. SUOMINEN, Jun. Am. Soc. C.E.
Philadelphia, Pa.

Seventy-First Annual Convention

San Diego, Calif., July 23–26, 1941

U. S. Grant Hotel to Be Headquarters

Opening Session and General Assembly

WEDNESDAY—July 23, 1941—Morning

9:00 **Registration**

9:45 **Convention called to order by**

C. Wayland Capwell, *President, San Diego Section, Am. Soc. C.E.; San Diego Gas and Electric Company,* San Diego, Calif.

9:50 **Address of Welcome**

His Honor Percy J. Benbough, *Mayor of the City of San Diego,* Calif.

10:05 **Response**

Frederick H. Fowler, *President, American Society of Civil Engineers*

10:10 **Annual Address**

Frederick H. Fowler, *President, American Society of Civil Engineers*

Business Meeting

12:00 **Luncheon Recess**

WEDNESDAY LUNCHEON FOR MEN

12:20 p.m.

At the close of the Wednesday morning session, there will be a luncheon for members and men guests in the Plata Real, U. S. Grant Hotel.

Maj.-Gen. H. B. Fiske, *U.S.A.* (*Retired*) will deliver at the luncheon an address on "Our Army."

Tickets for the luncheon are $1.00 each.

WEDNESDAY—July 23, 1941—Afternoon

Time, 2:30–4:30 p.m.

SYMPOSIUM ON NATIONAL DEFENSE

Under Auspices of the National Committee on Civilian Protection in War Time

Joseph Jacobs, *Vice-President, Am. Soc. C.E., Chairman;*
Walter D. Binger, *Chairman, National Committee on Civilian Protection in War Time, Presiding*

Since the appointment by the Board of Direction of a National Committee on Civilian Protection in War Time, similar local committees have been appointed in the area of each Local Section devoted to the study and needs of civilians in the event of enemy activity for the protection of their lives and their property against destruction.

Public consciousness of the need for constructive thinking is developing rapidly. Local committees of engineers are planning methods of protecting water supplies and other utilities against bombing and damage by sabotage.

This program is for the purpose of bringing up to date discussions which have developed since the appointment of the National Committee on Civilian Protection in War Time and for the exchange of experiences in local planning.

The National Committee consists of Walter D. Binger, Ernest P. Goodrich, J. I. Parcel, Samuel A. Greeley, Charles B. Breed, Philip Sporn, and Allen J. Saville, Members, Am. Soc. C.E.

2:30 **The Work of the National Technological Civil Protection Committee**

Walter D. Binger, *M. Am. Soc. C.E., Commissioner of Borough Works, Borough of Manhattan,* New York, N.Y.

2:40 **Sanitation and Public Health**

Paul E. Langdon, *M. Am. Soc. C.E., Consulting Engineer,* Chicago, Ill.

2:50 **Transportation and Distribution**

M. C. Blanchard, *M. Am. Soc. C.E., Chief Engineer, Coast Lines, Atchison, Topeka and Santa Fe Railway,* Los Angeles, Calif.; *Member, Los Angeles Section Committee on Civilian Protection.*

3:00 **Power and Communications**

H. A. Noble, *Assoc. M. Am. Soc. C.E., Superintendent of Electric Production, San Diego Consolidated Gas and Electric Company,* San Diego, Calif.; *Chairman, San Diego Section Committee on Civilian Protection.*

3:10 **Protection of Bridges and Buildings**

John I. Parcel, *M. Am. Soc. C.E., Consulting Engineer,* St. Louis, Mo.

3:20 **The Problem of Law Enforcement in Relation to Espionage and Sabotage**

L. R. Pennington, *Inspector, Federal Bureau of Investigation,* Washington, D.C.

3:30 **Relation Between Local Committees and Municipal and State Officials**

Ernest P. Goodrich, *M. Am. Soc. C.E., Consulting Engineer,* New York, N.Y.

3:40 **Open discussion**

WEDNESDAY—July 23, 1941—Evening

7:00 Dinner, Entertainment, and Dance—U. S. Grant Hotel

Dinner and entertainment in Palm Court. Dancing in Gold Room of the hotel following dinner and entertainment.

Tickets are $3.00 each. Tickets for Juniors for dance only are $1.50 per couple.

Entertainment for the Ladies

WEDNESDAY—July 23, 1941

Morning and Afternoon

Entertainment and Luncheon for Ladies

At the close of the morning session, the ladies will gather in the lobby of the U. S. Grant Hotel and go by busses to the Cafe del Rey Moro in Balboa Park for luncheon. Mrs. Belle Benchley, Director of the renowned San Diego Zoo, and author of *My Life in a Man Made Jungle*, will give a talk based upon her experiences.

After luncheon, the ladies may go to the nearby Art Gallery, the Natural History Museum, or the Zoo. The return to the U. S. Grant Hotel will be by busses about 5:00 p.m.

Tickets for the luncheon are $1.00 each.

Evening

Dinner and Entertainment Followed by Dancing

Dinner will be served under the stars at 7:00 o'clock in the Palm Court, U. S. Grant Hotel, followed by entertainment. Later there will be dancing in the hotel's Gold Room.

Tickets for the dinner and dance are $3.00 each.

Juniors and their ladies who do not care to attend the dinner and entertainment will be admitted for the dancing at $1.50 per couple.

THURSDAY—July 24, 1941

Trip to Palomar Observatory

Thee ladies will join the men in this all-day trip on Thursday. See Details elsewhere in program.

FRIDAY—July 25, 1941

Morning

Harbor Excursion for Ladies

At 9:30 a.m., the ladies will gather in the lobby of the U. S. Grant Hotel and go by busses to the foot of Broadway, where they will board an excursion boat for a two-hour trip around San Diego Harbor.

This will be a splendid opportunity to glimpse the vast Naval, Marine Corps, and aviation establishments that make San Diego one of the key cities in the national defense program.

At the conclusion of the trip, the ladies will be returned to the U. S. Grant Hotel.

This trip is complimentary to the visiting ladies.

LUNCHEON

At 12:30 p.m. the ladies will join the men at a luncheon in the Plata Real, U. S. Grant Hotel.

Mr. Alberto Campione, manager of the famous Hotel Del Coronado and an international figure, will be the speaker.

Tickets for the luncheon are $1.00 each.

Afternoon

Ladies' Automobile Tour

The ladies will gather in the lobby of the U. S. Grant Hotel at 2:00 p.m. and go by automobile to various points of interest in and about San Diego. These will include such historic and scenic points as Ramona's Marriage Place, Serra Museum, Mission San Diego de Alcala, U.S. Marine Corps Base, Naval Training Station, and the vast Linda Vista Housing project. At Camp Callan, at 4:00 p.m. there will be a regimental review in honor of the visiting ladies. After the review, the ladies will be taken to LaJolla Beach and Tennis Club for tea at 5:00 p.m. Trip and tea are complimentary to the visiting ladies.

Terrace, Cafe Del Rey Moro

California Tower

Fountain, Casa Del Rey Moro

VIEWS IN BEAUTIFUL BALBOA PARK, SAN DIEGO

TRIP TO OLD MEXICO AND RODRIGUEZ DAM

SATURDAY—July 26, 1941

The ladies will join the men in this all-day trip on Saturday.

San Diego's Downtown Business Section and San Diego Bay

Sessions of Technical Divisions

THURSDAY—July 24, 1941—Morning

HYDRAULICS DIVISION

Time, 9:00–11:00 a.m.

Fred C. Scobey, *Chairman, Executive Committee, Presiding*

9:00 **Hydraulic Similarity in Model and Prototype Locks**

Martin E. Nelson, *M. Am. Soc. C.E., Engineer in Charge*, and James J. Hartigan, *Assistant Engineer, U.S. Engineer Sub-Office*, Iowa City, Iowa.

9:30 **Discussion by**

M. P. O'Brien, *M. Am. Soc. C.E., Chairman, Department of Mechanical Engineering, University of California*, Berkeley, Calif.

A. E. Niederhoff, *Assoc. M. Am. Soc. C.E., Civil Engineer, U.S. Army Engineers, U.S. Engineer Office*, Portland, Ore.

9:40 **Comparison of Prototype to Model Flow Over Bonneville Dam**

J. C. Stevens, *M. Am. Soc. C.E., Consulting Engineer*, Portland, Ore., and R. B. Cochrane, *Assoc. M. Am. Soc. C.E., Engineer, U.S. Engineer Office*, Bonneville, Ore.

10:10 **Discussion by**

C. I. Grimm, *M. Am. Soc. C.E., Head Engineer, U.S. Engineer Department, North Pacific Division*, Portland, Ore.

10:20 **Superelevation and Bridge Pier Losses in Model and Field**

J. G. Jobes, *Assoc. M. Am. Soc. C.E., Senior Engineer, Chief, Hydraulic Section*, and J. H. Douma, *Jun. Am. Soc. C.E., Assistant Hydraulic Engineer, U.S. Engineer Department*, Los Angeles, Calif.

10:50 **Discussion by**

Robert T. Knapp, *M. Am. Soc. C.E., Associate Professor, Hydraulic Engineering, California Institute of Technology*, Pasadena, Calif.

HIGHWAY DIVISION

Time, 9:00–11:00 a.m.

William N. Carey, *Member, Executive Committee, Presiding*

9:00 **California's Plan for Freeways in the Metropolitan Area**

Fred J. Grumm, *M. Am. Soc. C.E., Engineer, Surveys and Plans, State Division of Highways, Department of Public Works*, Sacramento, Calif.

9:30 **Discussion opened by**

N. F. McCoy, *Senior Highway Engineer, U.S. Public Roads Administration*, San Francisco, Calif.

9:40 **General discussion**

9:50 **National Defense Highways**

L. I. Hewes, *M. Am. Soc. C.E., Chief, Western Region, U.S. Public Roads Administration*, San Francisco, Calif.

10:20 **Discussion opened by**

Richard H. Wilson, *Assoc. M. Am. Soc. C.E., Office Engineer, Division of Highways, Department of Public Works*, Sacramento, Calif.

10:30 **General discussion**

SANITARY ENGINEERING DIVISION

Time, 9:00–11:00 a.m.

A. M. Rawn, *Member, Executive Committee, Presiding*

9:00 **Reduction of Mineral Contents of Water with Carbonaceous Zeolites for Domestic, Irrigation and Industrial Use**

R. F. Goudey, *M. Am. Soc. C.E., Sanitary Engineer, Bureau of Water Works and Supply*, Los Angeles, Calif.

9:30 **General discussion**

9:40 **Effect of Emergency Upon Sewerage Facilities of San Diego**

B. D. Phelps, *Assistant City Engineer*, San Diego, Calif.

10:10 **General discussion**

10:20 **Character, Quality and Treatment of Well Water Supplies of the Los Angeles Coastal Plain**

Louis J. Alexander, *Assoc. M. Am. Soc. C.E., Designing Engineer, Southern California Water Company*, Los Angeles, Calif.

10:50 **General discussion**

TRIP TO PALOMAR OBSERVATORY—*THURSDAY—July 24, 1941*

Busses will leave the Fourth Avenue entrance of the U. S. Grant Hotel beginning at 9:30 a.m. and at intervals thereafter as fast as the busses are filled. The last bus will leave at 11:30 a.m. A buffet luncheon will be served at Grape Day Park, Escondido, with the Escondido Chamber of Commerce as host.

At Mt. Palomar, the party will be shown through the Observatory where the world's largest telescope, with 200-in. lens, soon will be exploring the vast reaches of the universe.

After this inspection trip the party will be taken to the State Park on Mt. Palomar, where an outdoor dinner will be served and Mexican entertainment provided. The busses will leave the mountain at about 8:00 p.m.

Tickets for the round trip, including luncheon and dinner, are $4.00 each.

Sessions of Technical Divisions

FRIDAY—July 25, 1941—Morning

CITY PLANNING DIVISION

Time, 9:30–12:00 a.m.

HARLAND BARTHOLOMEW, *Chairman, Executive Committee, Presiding*

9:30 Business District Rehabilitation and the Parking Problem
JOHN G. MARR, *Assoc. M. Am. Soc. C.E., Engineer, City Planning Commission*, Oakland, Calif.

10:00 General discussion

10:30 The San Diego Plan—Before, During, and After the Defense Program
GLENN A. RICK, *Director of Planning, Board of City Planning Commissioners*, Los Angeles, Calif.

11:00 Discussion opened by
LORIN W. DREWALL, *Assoc. M. Am. Soc. C.E., County Planning Engineer, San Diego County Planning Commission*, San Diego, Calif.

11:10 General discussion

SOIL MECHANICS AND FOUNDATIONS DIVISION

Time, 9:30–12:00 a.m.

CARLTON S. PROCTOR, *Chairman, Executive Committee, Presiding*

9:30 Introductory remarks
CARLTON S. PROCTOR, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

9:40 Seepage and Drainage in Earth Dams: Progress Report of Subcommittee on Piping and Drainage of the Committee on Earth Dams and Embankments of the Soil Mechanics and Foundations Division
CHARLES H. LEE, *M. Am. Soc. C.E., Consulting Engineer*, San Francisco, Calif.

Discussion by

10:10 S. O. HARPER, *M. Am. Soc. C.E., Chief Engineer, U.S. Bureau of Reclamation*, Denver, Colo.

10:20 PAUL BAUMANN, *M. Am. Soc. C.E., Senior Assistant Chief Engineer, Los Angeles County Flood Control District*, Los Angeles, Calif.

10:30 General discussion

10:40 Foundation Studies for the Proposed Harbor Steam Plant of the City of Los Angeles
WILLIAM F. SWIGER, *Jun. Am. Soc. C.E.*, Los Angeles, Calif.

Discussion by

11:10 R. G. HENNES, *Assoc. M. Am. Soc. C.E., Assistant Professor, Civil Engineering, University of Washington*, Seattle, Wash.

11:20 HARRY W. BOLIN, *Assoc. M. Am. Soc. C.E., Supervising Office Engineer, Division of Architecture, State Department of Public Works*, Los Angeles, Calif.

11:30 General discussion

IRRIGATION DIVISION

Time, 9:30–12:00 a.m.

S. T. HARDING, *Chairman, Executive Committee, Presiding*

9:30 Priming the All-American Canal
L. J. FOSTER, *Construction Engineer, U.S. Bureau of Reclamation*, Yuma, Ariz.

10:00 Discussion opened by
M. J. DOWD, *M. Am. Soc. C.E., Chief Engineer and General Superintendent, Imperial Irrigation District*, Imperial, Calif.

10:10 General discussion

10:30 Reduction of Conveyance Loss in Irrigation Distribution
E. B. DEBLER, *M. Am. Soc. C.E., Hydraulic Engineer, U.S. Bureau of Reclamation*, Denver, Colo.

Discussion by

11:00 ALFRED TAMM, *Assoc. M. Am. Soc. C.E., Consulting Engineer*, Harlingen, Tex.

11:10 HARRY BARNES, *M. Am. Soc. C.E., Chief Engineer and Secretary, Madera Irrigation District*, Madera, Calif.

11:20 General discussion

POWER DIVISION

Time, 9:30–12:00 a.m.

WILLIAM P. CREAGER, *Chairman, Executive Committee, Presiding*

9:30 Determining Factors in the Design of Shasta Dam
K. B. KEENER, *M. Am. Soc. C.E., Designing Engineer on Dams, U.S. Bureau of Reclamation*, Denver, Colo.

Discussion by

10:00 JULIAN HINDS, *M. Am. Soc. C.E., Chief Engineer, Metropolitan Water District of Southern California*, Los Angeles, Calif.

10:10 CHARLES H. PAUL, *M. Am. Soc. C.E., Consulting Engineer*, Dayton, Ohio.

10:20 General discussion

10:30 Design Features of the Shasta and Keswick Power Developments
L. N. MCCLELLAN, *Chief Electrical and Mechanical Engineer*, and CECIL L. KILLGORE, *Associate Engineer, U.S. Bureau of Reclamation*, Denver, Colo.

11:00 Discussion

11:10 General discussion

FRIDAY LUNCHEON FOR MEMBERS, LADIES, AND GUESTS

At the close of the Friday morning technical sessions, there will be a luncheon for members, ladies, and guests in the Plata Real, U. S. Grant Hotel, at 12:30 p.m.

Mr. Alberto Campione, manager of the famous Hotel Del Coronado and an international figure, will be the speaker.

Tickets for the luncheon are $1.00 each.

Occupy Entire Day, Friday

FRIDAY—July 25, 1941—Afternoon

IRRIGATION DIVISION

Time, 2:00–4:30 p.m.

S. T. Harding, *Chairman, Executive Committee, Presiding*

2:00 **Distinctive Features of the Irrigation Systems in San Diego County**

Fred D. Pyle, *M. Am. Soc. C.E., Hydraulic Engineer, City of San Diego*, Calif.

Discussion by

2:30 J. B. Lippincott, *Hon. M. Am. Soc. C.E., Consulting Engineer*, Los Angeles, Calif.

2:40 Kenneth Q. Volk, *M. Am. Soc. C.E., Consulting Engineer*, Los Angeles, Calif.

3:00 **Classification of Irrigable Lands**

W. W. Johnston, *Reclamation Economist, U.S. Bureau of Reclamation*, Ephrata, Wash.

3:30 **Discussion opened by**

R. E. Storie, *Lecturer in Soil Technology, University of California*, Berkeley, Calif.

3:50 **Use of Water in Mexico from Spanish Colonial Days**

Francisco Gomez-Perez, *Assoc. M. Am. Soc. C.E., Civil Engineer*, Mexico, D. F., Mexico.

POWER DIVISION

Time, 2:00–4:30 p.m.

William P. Creager, *Chairman, Executive Committee, Presiding*

2:00 **Electric Power Supply of California and the Southwest**

Lester S. Ready, *Consulting Engineer*, San Francisco.

Discussion by

2:30 A. R. Arledge, *Assoc. M. Am. Soc. C.E., Principal Civil Engineer, Los Angeles Bureau of Power and Light*, Los Angeles, Calif.

2:40 W. L. Chadwick, *M. Am. Soc. C.E., Chief Civil Engineer, Southern California Edison Company*, Los Angeles, Calif.

3:00 **Maintenance of Concrete Dams: Report of Joint Committee on Masonry Dams**

A. V. Karpov, *M. Am. Soc. C.E., Consulting Engineer*, Pittsburgh, Pa.; *Power Division Representative on Joint Committee.*

3:30 **Discussion**

HYDRAULICS DIVISION

Time, 2:00–4:30 p.m.

J. Q. Jewett, *Member, Executive Committee, Presiding*

2:00 **Hydraulic Design of Drop Structures for Gully Control**

Brooks T. Morris, *Jun. Am. Soc. C.E., Cooperative Agent, U.S. Department of Agriculture, Soil Conservation Service, Cooperative Laboratory, California Institute of Technology*, Pasadena, Calif., and Donald C. Johnson, *Assistant Regional Engineer, U.S. Department of Agriculture, Soil Conservation Service, Pacific Southwest Region*, Berkeley, Calif.

3:00 **General discussion**

3:15 **Design of Curves for High-Velocity Channels**

Robert T. Knapp, *M. Am. Soc. C.E., Associate Professor, Hydraulic Engineering, California Institute of Technology*, Pasadena, Calif.

3:45 **General discussion**

4:00 **Motion Picture Demonstration: The Transportation of Sediments Through Reservoirs**

Broadway, San Diego
Looking West Toward Convention Headquarters

SOIL MECHANICS AND FOUNDATIONS DIVISION

Time, 2:00–4:30 p.m.

Carlton S. Proctor, *Chairman, Executive Committee, Presiding*

2:00 **Progress Report of the Joint Committee on Seismology**

R. V. Labarre, *M. Am. Soc. C.E., Consulting Foundation Engineer*, Los Angeles, Calif.; *Chairman of Joint Committee.*

2:10 **Soil Compaction and Stabilization**

Spencer J. Buchanan, *M. Am. Soc. C.E., Engineer, Mississippi River Commission*, Vicksburg, Miss.

Discussion by

2:40 T. A. Middlebrooks, *Assoc. M. Am. Soc. C.E., Senior Engineer, Corps of Engineers, War Department, Soil Mechanics Section*, Washington, D.C.

2:50 W. J. Turnbull, *Assoc. M. Am. Soc. C.E., Soils Engineer and Chief of Laboratory, The Central Nebraska Public Power and Irrigation District*, Ogallala, Nebr.

3:00 **General discussion**

3:10 **A New Departure in Transmission Tower Foundations**

Kenneth A. Reeder, *M. Am. Soc. C.E., Structural Engineer, Southern California Edison Company*, Los Angeles, Calif.

Discussion by

3:40 A. R. Stuckey, *Assoc. M. Am. Soc. C.E., Resident Engineer, Stone and Webster Engineering Corporation*, Upland, Calif.

3:50 I. C. Steele, *M. Am. Soc. C.E., Chief, Division of Civil Engineering, Department of Engineering, Pacific Gas and Electric Company*, San Francisco, Calif.

4:00 **General discussion**

Conference of Juniors

TUESDAY—July 22, 1941

It has seemed desirable to the Juniors of the Los Angeles Section to have a conference at which representatives of Junior organizations could share their experiences. It is hoped that representatives of organized groups will attend and that Juniors from Sections which have no special Junior group will be present as well to discuss the problems in their own localities. Every Junior who wishes to be present will be welcomed and is invited to participate in the discussions.

Morning, 9:30–12:00 a. m.

GEORGE E. BRANDOW, *President, Junior Forum, Los Angeles Section, Presiding*

9:30 **Welcome by**
GEORGE E. BRANDOW, *Jun. Am. Soc. C.E., Structural Engineer, John C. Austin*, Los Angeles, Calif.

Response for the Society Committee on Juniors
C. G. DUNNELLS, *M. Am. Soc. C.E., Consulting Engineer*, Pittsburgh, Pa.; *Board Member, Committe on Juniors.*

The Junior Meets His Problem
(a) **State Registration Examination Study Group**
San Francisco Section Representative
(b) **Participation in Local Section Activities**
Los Angeles Section Representative
(c) **Program and Membership in the Junior Forum**
Sacramento Section Representative
(d) **The Junior in the Small Local Section**
San Diego Section Representative

12:00 **Adjournment for Luncheon with Representatives of Local Sections**
Luncheon in the Plata Real, U. S. Grant Hotel.

Afternoon, 2:00–4:30 p.m.

2:00 **Joint Meeting of Juniors with Representatives of Local Sections**
It is hoped that this Conference of Juniors will assist Juniors better to serve themselves, the Society, and the profession.

Local Sections Conference

TUESDAY—July 22, 1941

Morning, 9:30–12:00 a.m.

J. T. L. MCNEW, *Chairman, Society Committee on Local Sections, Presiding*

All interested members of the Society are invited to attend the conference of representatives of the Western Local Sections and to participate in the discussions. The official representatives will discuss generally the following two main questions, and in detail the specific subjects listed below.

How Can Local Sections Be of Greatest Assistance in the National Defense Construction Program?

How Can Local Sections Be of Greatest Benefit to the Profession?

9:30 (a) **Address of Welcome**
C. WAYLAND CAPWELL, *President, San Diego Section*
(b) **Is the Supply of Civil Engineers Adequate for Defense Construction?**
(c) **Training Civil Engineers for National Defense Industry**
(d) **How Are Civil Engineers Affected by the Wages and Hours Act?**
(e) **What Is the Effect of Technical Unionization on the Civil Engineering Profession?**
(f) **How Do Local Selective Service Draft Boards Defer Civil Engineers?**

12:00 **Adjournment for Luncheon with Junior Representatives in the Plata Real, U. S. Grant Hotel**

Afternoon, 2:00–4:30

2:00 **Junior Representatives Join the Conference**
(g) **Society Aid in the National Defense Program**
FREDERICK H. FOWLER, *President, Am. Soc. C.E.*
(h) **Relation of Local Sections to Local Government**
(i) **Civil Engineers Part in Post War Emergency Planning for Public Works Construction**
(j) **The Juniors' Part in Section Activities**
(k) **Report on 1940 Section Activities**
(l) **What Duties and Functions Can Be Turned Over to Local Sections?**
GEORGE T. SEABURY, *Secretary, Am. Soc. C.E.*

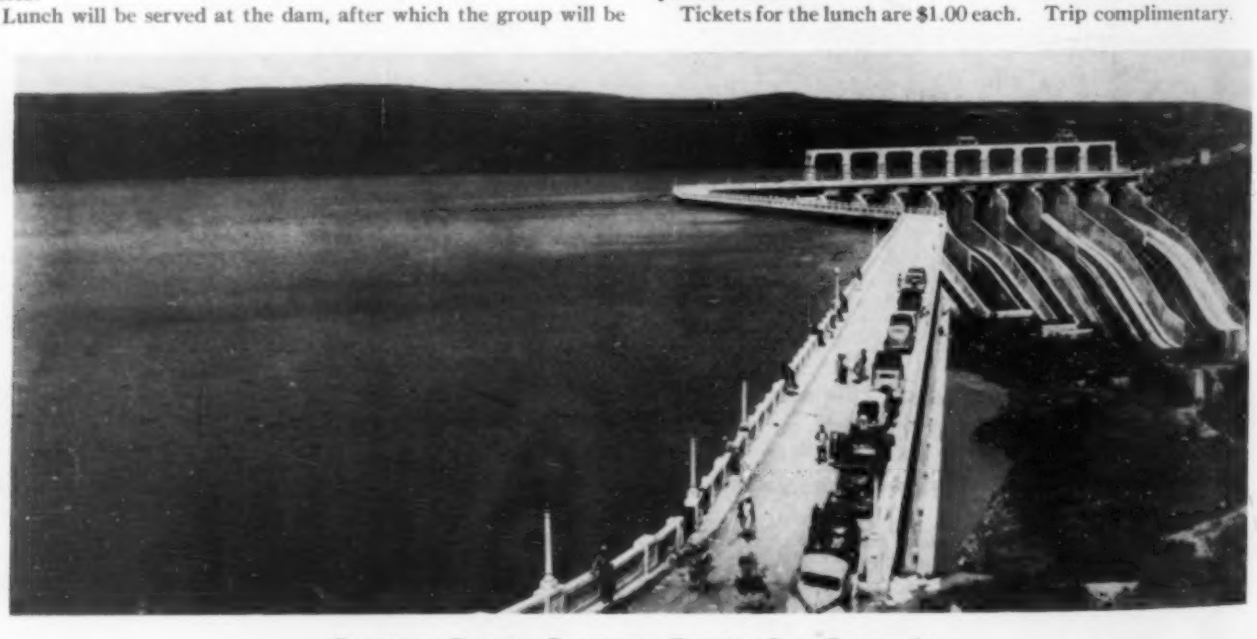
Trip to Old Mexico and Rodriguez Dam

SATURDAY—July 26, 1941

Cars will leave the U. S. Grant Hotel at 9:30 a.m. for Old Mexico. There the party will be met by prominent Mexican officials and taken to Rodriguez Dam, the highest Ambursen-type dam in the world.

Lunch will be served at the dam, after which the group will be taken to Tijuana, a quaint and colorful Mexican town. The party will visit the Agua Caliente Industrial School, housed in the magnificent buildings which formerly comprised the Agua Caliente pleasure resort.

Tickets for the lunch are $1.00 each. Trip complimentary.



RODRIGUEZ DAM AND RESERVOIR, TIJUANA, BAJA CALIFORNIA

Hotel Accommodations and Announcements

Hotel Rates

Hotels	Single Rooms With Bath	Single Rooms Without Bath	Double Rooms With Bath	Double Rooms Without Bath
U. S. Grant	$3.00 up	$2.00 up	$4.00 up	$3.00 up
Del Coronado*	8.00	...	6.50 up	...
El Cortez	3.50 up	...	5.50 up	...
Maryland	2.50 up	1.50 up	3.50 up	2.50 up
Park Manor†	4.00 up	...	8.00 up	...
Pickwick	2.50	...	3.50 up	...
San Diego	2.50 up	1.50 up	3.50 up	2.00 up

* All rates are American plan, per day, per person, which includes all meals.
† Housekeeping apartments.

THE U. S. GRANT, ONE OF SAN DIEGO'S LEADING DOWNTOWN HOTELS

The U. S. Grant Hotel is the Society Headquarters for the Convention.

Members are urged to make definite arrangements for rooms at least a week in advance of the Annual Convention, paying for the rooms in advance for at least a part of the period they expect to be in San Diego.

All those who attend the Annual Convention are requested to register immediately upon arrival at meeting headquarters. Special badges and tickets will be issued at the time of registration.

Order All Tickets in Advance

Members who order tickets in advance not only will be saved delay by having tickets and badges awaiting them on arrival at headquarters, but they will assist the committee greatly by giving advance information to guide it in concluding arrangements. **See page 31 of Advertising Section for Ticket Order Form.**

Information

A registration desk will be provided in the headquarters hotel to assist visiting members in securing any desired information about the city. At the registration desk there will be a card file of those in attendance, with information on members' San Diego addresses.

Golf Information

There are several fine golf courses available to the members attending the Convention. Those desiring to play are requested to consult the Convention Information Desk in the U. S. Grant Hotel.

Deep Sea Fishing

Deep sea fishing is one of the most popular attractions in San Diego. Yellowtail, tuna, and white sea bass are caught in abundance in the vicinity of Coronado Islands, 18 miles from San Diego, during the summer months. A special charter party will be arranged for this trip if twelve or more members desire. A great thrill is in store for those who succeed in hooking and landing these fighters. Girls at the Information Desk will assist in making the necessary arrangements.

Entertainment for the Ladies

Attention is directed to the entertainment provided for the ladies. It is expected that they will participate with the members in any other features of the program in which they are interested.

Local Committees on Arrangements

Executive Committee

C. WAYLAND CAPWELL, *Chairman*

PAUL BEERMANN
M. H. BLOTE
EDWARD R. BOWEN
LORIN W. DEEWALL
WALTER DRYER
NORMAN MCLEAN
FRED D. PYLE
C. BOONE SADLER

Program Committee

FRED D. PYLE, *Chairman*

H. W. JORGENSEN
NORMAN MCLEAN
H. A. NOBLE

Publicity Committee

T. G. ARMSTRONG
NORMAN MCLEAN
MRS. H. A. NOBLE
C. E. SMITH

Transportation and Excursion Committee

PAUL BEERMANN, *Chairman*

L. L. MILLS
C. P. WILLIAMS

Entertainment Committee

C. WAYLAND CAPWELL, *Chairman*

WILLIAM C. BROWN
C. B. IRELAND
J. A. WAHLER

Reception Committee

W. W. CROSBY, *Chairman*

TOM J. ALLEN
LOUIS BODMER
TRENT R. DAMES
H. B. HAMMILL
W. W. HURLBUT
L. M. KLAUBER
EDWARD M. KNAPIK

Hotel and Registration Committee

H. A. NOBLE, *Chairman*

CHARLES M. ADAMS
PAUL BEERMANN
CARL H. HEILBRON

Finance Committee

C. WAYLAND CAPWELL
LORIN W. DEEWALL
NORMAN MCLEAN
C. BOONE SADLER

Rodriguez Dam Excursion Committee

CHARLES P. WILLIAMS, *Chairman*

W. C. BROWN
FRANCISCO GOMEZ-PEREZ
C. B. IRELAND
GEORGE F. MCEWEN

Ladies Committee

MRS. C. WAYLAND CAPWELL, *Chairman*
MRS. H. A. NOBLE, *Vice-Chairman*

MRS. CHARLES M. ADAMS
MRS. TOM J. ALLEN
MRS. PAUL BEERMANN
MRS. WILLIAM C. BROWN
MRS. W. W. CROSBY
MRS. LORIN W. DEEWALL
MRS. C. B. IRELAND
MRS. H. W. JORGENSEN
MRS. L. M. KLAUBER
MRS. GEORGE F. MCEWEN
MRS. NORMAN MCLEAN
MRS. L. L. MILLS
MRS. FRED D. PYLE
MRS. C. BOONE SADLER
MRS. C. E. SMITH
MRS. J. A. WAHLER

The program as a whole has been prepared under the direction of the Western Region Meeting Committee, composed of JOSEPH JACOBS, *Vice-President, Am. Soc. C.E., Chairman;* and EDWARD S. BRES, JOHN W. CUNNINGHAM, CHARLES GILMAN HYDE, and CHARLES T. LEEDS, *Directors, Am. Soc. C.E.*

Please call on the Local Committee on Arrangements or on the Secretary's office for any service desired.

SOCIETY AFFAIRS

Official and Semi-Official

Student Guidance Progresses in the New York Area

Excerpts from Annual Report on Joint Committee Work in 1940–1941

The New York Engineers Committee on Student Guidance is a joint committee of the five constituent committees of the Metropolitan or New York Sections of the Four Founder Societies and of the American Institute of Chemical Engineers.

Objective

The specific objective of the committee is to assist the student counselors of the high schools in greater New York to present a true picture of engineering to students who have expressed a desire to enter an engineering school and thereafter to adopt engineering as a career. Many students choose an engineering career because of parental influence. Others make their own choice without giving due consideration to the special aptitudes necessary for success. This is the principal cause of the very high mortality in the first two or three years in engineering colleges and the additional mortality in the profession after graduation. The committee helps students by clarifying their ideas. The students learn first hand from practicing engineers, what qualifications and aptitudes are necessary for success in the profession and the extent of preliminary engineering education it is advisable to have.

It has been impossible as yet to institute a check-up system to follow the subsequent careers of about 2,000 students advised in the course of a single year, but the student advisers in the schools do report that the committee has been instrumental in steering much poor engineering material away from the profession as well as guiding some excellent material into the profession. The outside contact between students and engineers in practice is therefore welcomed even by schools whose graduates are successful, above the average, in engineering colleges. Promising students are advised as to accredited curricula, as well as in other matters, but no particular college is advertised.

Conduct of a Year's Program

It is necessary for someone on the committee to keep in touch with each high school during the year; to fix dates for meetings in such a way that meetings will be properly distributed throughout the year; to arrange programs and to insure the attendance of a sufficient number of committee representatives to take care of the expected number of students. Committee members are selected according to the expressed interest of students in the several branches of engineering. The chairman and secretary of the committee must therefore do a great deal of preliminary work each year in order to make the program a success.

The interest of the school officials is sustained in two ways. Early in the school year a brief report of the previous year's work is sent to each high school principal, accompanied by a request for the appointment of a contact member from the staff of the school, usually an administrative assistant or the chairman of the school's guidance committee. Second, a luncheon meeting and conference is arranged (usually in October) which is attended by the members of the engineers' committee and the contact members of the several schools. Such a meeting enables the engineers and the representatives of the schools to become acquainted with each other and also offers an opportunity for discussion of the work. Importance and interest have been added to these luncheon conference meetings by the fact that some one or other of the universities in the New York area has always acted as host for the occasion.

Committee Meetings

The committee as a whole meets twice a year: at the beginning of the school year to plan the work ahead and at the end to review the year's work. These are dinner meetings. Each constituent committee holds separate meetings as it sees fit in order that new members may become acquainted with the older members of their own group and learn the methods of instructing students. This can be done better in the smaller groups than in the larger meetings of the joint committee.

Group Meetings

In the conduct of group meetings at the schools the entire group of students is first addressed on the nature of engineering work, the qualifications necessary for success in the practice of the profession, and the nature of the education that is necessary as a foundation for an engineering career. Following this, four or five smaller groups are formed, each led by an engineer, for more detailed discussion. The general talk is limited to twenty minutes, while the remainder of the session continues as long as the students themselves keep things going, usually two hours or more. Occasionally the janitor's duties end the proceedings.

This year, as in previous years, the average student attendance at each school was about 80, and four or five committee members attended each meeting. Detailed records giving the name of each school, the number of students in the groups, and the names of the committee members attending each school meeting are in the files of the committee.

A grand total of 30 group meetings in 27 high schools were held during the school year 1940–1941. The total student attendance for the year was 2,245. This is creditable since no effort is made by the schools to induce students to attend. Attendance is voluntary and the meetings take place after school hours on the students' own time.

Brooklyn Technical High School was accorded special consideration on account of the large number of its graduates who enter engineering colleges. During meetings held on three consecutive days a total of 267 students were interviewed at this school.

An innovation was tried at Franklin K. Lane High School by special request of the school. A general talk and discussion on the aptitudes necessary for success in an engineering school and the qualities and training necessary for success in the profession was accompanied by an illustrated lecture on a civil engineering project given by Alfred Hedefine, Assoc. M. Am. Soc. C.E. Students in all grades attended, and in succeeding years they will be given illustrated talks in other branches of engineering.

Other Meetings

In addition to the group meetings, general assemblies of students are occasionally addressed on engineering as a career by some prominent engineer recommended by the committee. The officers of the committee are frequently invited to attend meetings of the Administrative Assistants Association, the Division of Guidance and Placement, the Science Council, and other like organizations of the New York City school system. This is convincing evidence of the hearty cooperation of the school staffs without which the engineers' committee could not succeed.

Literature

The committee has prepared a bibliography of books on engineering suitable for high school students, describing the nature of engineering work. Copies of this bibliography and two copies of "Accredited Engineering Curricula," published by the Engineers Council for Professional Development, are left at each high school for its library. These are put to good use. A "Guide for Student Counselors" has been prepared for the use of committee members in counseling students.

Personal Interviews

Personal interviews with engineers in practice have been granted, as in previous years, to selected students. Students with a real

problem on their hands may apply to their school counselor for such consultations. The school furnishes pertinent information as to the student's capabilities on a form provided by the committee, and each application is examined by the chairman of the joint committee before being referred to the chairman of the constituent committee representing the main branch of engineering in which the student is particularly interested. After the interview has been completed the engineer's report is returned to the chairman of the joint committee for entering in the records, and a duplicate copy is sent to the school.

Many letters received from high schools comment on these interviews. For example, one placement counselor reported:

"A very significant by-product of this informal meeting is that these youngsters are still filled with awe and wonder at the fact that perfect strangers to them should give so generously of their time and effort with no thought of material reward. With the existing state of affairs at home and abroad, I think this is a very wholesome and refreshing reaction."

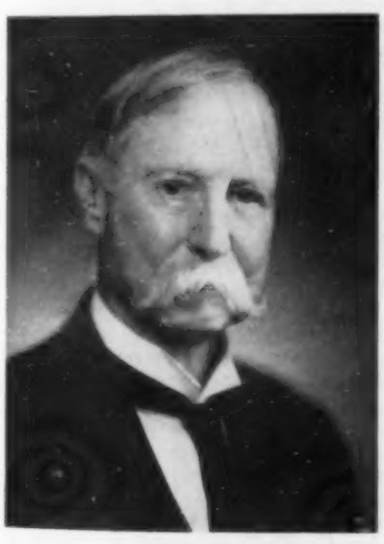
In all, seventy-odd members represent the five sponsor organizations. The following officers of the joint committee form the executive committee:

A. G. Hayden, Chairman—Metropolitan Section, Am. Soc. C.E.
W. H. Larkin, Vice-Chairman—Metropolitan Section, A.S.M.E.
Z. G. Deutsch, Secretary-Treasurer—New York Section, A.I.Ch.E.
James M. Comly—New York Section, A.I.E.E.
Scott Turner—New York Section, A.I.M.E.

Thomas U. Taylor Dies

THOMAS U. TAYLOR, dean emeritus of the college of engineering at the University of Texas, died at Austin, Tex., on May 28, 1941. Dean Taylor, who was 83, was dean at the university from 1895 to 1936. Since the latter date he had held the title of dean emeritus.

Dean Taylor was born on a farm in Parker County, Texas. His early years were spent on the frontier, when Indian raids were of common occurrence, and all his life he delighted to tell stories of pioneer adventure. He received his bachelor degree in civil engineering from the University of Virginia in 1883, the year the University of Texas was opened, and his master of civil engineering degree from Cornell in 1898.



THOMAS U. TAYLOR 1858–1941

Before starting his long career of teaching in 1888, Dean Taylor worked as principal assistant engineer to the state of Texas on survey work, as assistant engineer with J. A. L. Waddell on bridge design, and as hydrographer for Texas for the U.S. Geological Survey. During his teaching work he served as consultant on water supply problems for the cities of Abilene, Austin, Dallas, Fort Worth, and Wichita Falls.

Affectionately known to generations of University of Texas students as "T.U." or "the old man," Dean Taylor was very much of a campus institution. His personality was as vigorous and colorful as ever in January 1940, when he came to New York to attend the Annual Meeting and be made an Honorary Member of the Society. His membership in the Society dated back to 1893, when he became an Affiliate. He joined as an Associate Member in 1895, and became a full member in 1901.

San Francisco Junior Forum Helps Candidates for Professional Examinations

A WORTHWHILE activity for Local Sections or Junior Forums is exemplified by the recent experience of the San Francisco Section in helping candidates for the civil engineering examinations of the State Board of Registration for Civil Engineers. An account of this activity is given in the April issue of *The Registered Civil Engineer*, news bulletin of the California State Board.

The Juniors planning to take this examination decided they needed help. Failing to find a satisfactory university extension course, the Junior Forum decided to proceed on its own. As an example and encouragement to other Sections, the following notes are abstracted from the news bulletin.

The problems of past examinations were classified according to type and put into the following eight divisions: structural analysis and design, hydraulics, specifications, engineering economics, concrete sizes, construction, surveying, and miscellaneous.

Next, representative problems in each division were selected. A program of seven weekly evening meetings or seminars was arranged, each to be devoted to one of the eight divisions. Blueprinted syllabuses of the study course were made, to be used in the seminars. At the end of each session, certain members of the class volunteered to prepare solutions of problems selected for presentation at the following meeting. At this next meeting, these members placed their solutions on the blackboard and explained them. A general discussion of methods and ideas followed, together with comments.

There was no instructor for any session. The chairman of the committee who arranged the meetings acted as chairman of the seminars in order to provide continuity of effort. One or more of the older and more experienced members of the San Francisco Section were asked to be present at each session to act as advisers and to give their opinions on any doubtful points which might arise. The average attendance at the weekly seminars was 23 members, with a minimum of 20 and a maximum of 26.

At the last session, a short time was devoted to a discussion of the study course with the thought of presenting helpful suggestions for future work. The following is a summary of these suggestions:

1. More time than two hours should be devoted to each session. At least $2^1/_2$ hours should be the minimum.
2. More time should be devoted to discussion of methods of solution than to actual numerical calculations. In this regard, it was suggested that each man to whom a problem had been assigned for solution and explanation should first state his problem, and then outline the general procedure for solution to be followed and, lastly, indicate the numerical solution. The point was stressed that methods were more important than numerical calculations.
3. It was generally agreed that the method of arranging for problem solutions by volunteers had proved quite satisfactory, but there should always be at least two volunteers for each problem.
4. The method of having the same person act as chairman for all sessions was considered advantageous.
5. It was felt that, apart from actual aid in preparation for examination, valuable information had been obtained as to where various data could be found; what references and handbooks would be of use in certain types of problems; and in general it was agreed that such a study course could be of definite help in adding to the store of engineering knowledge of those attending.

It is worth noting that all who attended the seminars, and subsequently took the written examination in Civil Engineering Design and Construction, passed that examination and were given registration as civil engineers.

San Diego Convention, July 23 to 26—For Complete Program See Page 435

Design for Democracy

By KARL H. MIDDENDORFF

Engineer of the Widmer Engineering Company, Topeka, Kans.

At the April meeting of the Kansas Section, held at Manhattan, Kans., a number of engineers were present from the Fort Riley cantonment project. Based in part on his observations during this work, Mr. Middendorff gave a stirring talk, from which the following paragraphs are taken.

"HOWEVER calloused we may have become, however much we may have failed, still equality of opportunity, freedom of speech, impartiality of justice, and compassion for our fellowmen remain the goal of our democracy. To the doctrine of supermen, controlled speech, regimented life, concentration camp justice, greed and hatred we must forever be opposed or surrender our birthright. By vicious but clever propaganda a whole nation of normally lovable people has been inoculated with the spirit of oppression and violence. Hitler could be destroyed tomorrow, but this driving demon of evil would march on! There will be no peace for men of good will until we have licked this evil thing and licked it completely. There is no compromise!

"Materially we are preparing, but many of our citizens have failed to realize that unless we march forward, united with a crusading zeal, democracy will be wiped off the earth. Not all have failed in this realization. That is why on the Fort Riley reservation since last November as many as 9,000 men have cheerfully toiled daily in mud almost to their knees to build housing for a coming army. Almost a thousand buildings, sixty miles of streets and roads, thirty miles of sewers, forty miles of water line, enough lumber to roof an area a mile square, and blueprint paper that would cover a twenty-acre pasture are some of the physical evidences of the feverish preparations on this work. These buildings, built at the rate of one every sixty minutes over a period of five months—barracks, mess halls, stables, recreation buildings, 1,000-man theaters, service clubs, schools—large as these operations may seem and are, they represent but a small part of our mighty preparation. Fort Riley is less than one-tenth of one per cent of our preparedness program.

"We at Fort Riley are proud, however, that we have led the way in always meeting every troop schedule under terrible weather handicaps, but we also realize the rest of the nation is not far behind. And yet these material things, mighty as they are, will fail without a crusading spirit of loyalty and devotion to the principles of our way of life. Our men on the job have developed that spirit. I want you to know that our engineers have cheerfully worked 30 to 50% overtime and without extra compensation to get this job done. I want you to know that the contractors have used their equipment in mud that has wrecked and depreciated it far beyond the rental received. There were times when over half the equipment was in the shops. I want you to know that the workmen from Kansas on this job never thought of calling a strike.

"There are people living in this country who would rather see our democracy fail than forego their selfish desires for the common good. I believe in the profit system, but this is no time for high-jacking. I believe in collective bargaining, but this is no time for strikes to settle jurisdictional disputes or force closed shops. Every man has a right to work for his country and without duress. The time has come for the American people to ostracize the profiteer and the labor racketeer, and I mean completely.

"Democracy is not a new thing; its principles have been the hope of mankind throughout the ages. It has gone down under the heel of the oppressor before, but always to rise again. Democracy will not fail to ultimately survive. But to us is left the determination as to whether it shall be struck down in our day, or whether we shall save it for posterity. There is an insidious force abroad in our land. The political crook, the profiteer, the labor racketeer—each in his own bailiwick has been admired, called clever, and copied. They have refused to recognize any necessity for sacrifice or service. Selfishly they would let America die—yes, some of them would abet that death. Until we, as a nation, are willing to castigate them and turn our faces resolutely backward to the fundamentals of democracy, we will not be fully prepared to defend the principles on which this government was founded.

"I have faith that we will remember our heritage and with firm resolve will maintain in our day the 'blessings of liberty to ourselves and our posterity.'"

Redevelopment of Blighted Land

IN THE June issue of PROCEEDINGS, F. Dodd McHugh, Director of Planning, Department of City Planning, New York, N.Y., writes of the "Cost of Public Service in Residential Areas." The subject of the paper has particular significance in view of the recent passage, in the New York State Legislature, of the so-called Urban Redevelopment Corporations Bill (Senate, Introduction No. 408).

The steady migration of city dwellers to new suburban areas creates a problem in economics, which this paper and the Redevelopment Bill are designed to correct. When old sections lose population, public services in these sections must be maintained, and they are usually operated below actual capacity. This applies to storm and sanitary sewers, power and light lines, police and fire stations, schools, and similar items. Meanwhile all these facilities must be constructed anew in the suburban areas.

Mr. McHugh has presented a careful economic study of city planning problems that should be considered, giving numerous valuable unit costs necessary for comparisons.

Nebraska Salaries Raised

AS A PROMPT and gratifying sequel to the survey and recommendations made with respect to Nebraska State engineering employees a few months ago, it can now be announced that most of the recommendations have been adopted, and on July 1 an average salary increase of 16.3% will be effective for 373 engineers in the Highway and Irrigation bureaus of the state.

Grade specifications for four subprofessional and seven professional grades were adopted intact as presented in the report. A service record system and job descriptions have been authorized and are in the course of preparation as recommended by the report. These recommendations have thus been adopted exactly as submitted.

In connection with the salary ranges, the report recommended several successive steps. The intermediate step has been approved for the subprofessional grades and the first four professional grades, effective July 1, which will add in excess of $100,000 to the annual payroll for these engineers. The present salary of the State Engineer is fixed by law and will require legislative action if it is to be changed in accordance with the recommendations in the report. This position is classified as Grade 7. In Grades 6 and 5, moderate increases will be put into effect on July 1, with the intention of supplementing them with further raises later in the year.

At the same time, the scale of subsistence allowances which has been in effect for several years will be somewhat reduced, but it is believed that in no case will the employee on field duty receive less income from the new base pay plus new field allowance rates.

One of the strongest arguments for a readjustment of engineering salaries in Nebraska was that a very large number of engineers had recently migrated elsewhere to positions with increased salaries. Detailed statistics on this situation and a notation that 28 members of the engineering staff were currently considering offers of positions outside the department, were submitted by State Engineer Scott, who made strong recommendations to Governor Griswold that substantial salary raises be instituted promptly.

Giving his formal approval of the State Engineer's request, Governor Griswold wrote:

"It would appear at first glance that under the present economic conditions, it is improper and virtually impossible to increase salaries at this time. We are, however, faced with a condition and not a theory and it is your responsibility to see that the work of the department of roads and irrigation is properly conducted.

"In the technical branches of your department," the Governor continued to Scott, "it is impossible to do the work if too much change takes place, and I believe it to be vitally essential that the capable engineers and technically trained employees be retained.

"You therefore have my permission to put into effect the salary increases which you consider necessary in order that the work of the department shall not be hampered.

"At this time," the Governor concluded, "I desire to say also that I have been very pleased at the manner in which you have handled your duties since we have been in office, and I congratulate you upon the fine work you have so far accomplished."

More Student Chapter Conferences

Seven of the fourteen Regional Student Chapter Conferences, held under the auspices of the Society's Committee on Student Chapters during the past spring, were reported in the June issue of "Civil Engineering." Word of three more Conferences in widely separated parts of the country—Troy, N.Y., New Braunfels, Tex., and Laramie, Wyo.—has now been received at Society Headquarters.

Rocky Mountain—April 25

One hundred and fifty students coming from six schools in the Rocky Mountain region were in attendance at the Second Annual Rocky Mountain Conference of Student Chapters held on the campus of the University of Wyoming, April 25. Schools represented at the conference, in addition to the host Chapter, were the University of Utah, University of Colorado, Colorado State College, Utah State College, and the University of New Mexico.

During the morning delegates and faculty visited the Laramie plants of the Monolith Portland Midwest Company and the Forest Products Treating Company. At noon the students were guests of the two local companies at a luncheon served in the Wyoming Union building on the university campus. The president of the conference, C. E. Bowers, of the University of Wyoming, served as toastmaster, and C. L. Eckel, professor of civil engineering at the University of Colorado, addressed the group. The visitors were welcomed by Prof. A. J. McGaw, faculty adviser to the University of Wyoming Student Chapter.

Following the luncheon the official delegates adjourned to a business meeting, and the rest of the visitors were conducted about the campus. Colorado State College was selected as host for the 1942 meeting. The officers elected for the year 1942 were: Milton Moreland (Colorado State), president; Tom Punshon (Colorado University), vice-president; and Don Moore (Colorado State), secretary-treasurer. Both delegates and faculty were enthusiastic at the success of the conference.

Texas—May 9–10

The fourth conference of the Student Chapters in Texas was held at the time of the spring meeting of the Texas Section at New Braunfels, May 9 and 10. Registration took place in the afternoon, with representatives present from the University of Texas, Rice Institute, Southern Methodist University, and Texas Technological College. Unfortunately the conference conflicted with Engineers' Day at the Agricultural and Mechanical College of Texas, so there were no delegates from the latter. The conference then opened with the presentation of student papers in competition for prizes awarded by the Section. Four papers were presented as follows: "Theoretical Performance of the Lubbock South Storm Sewer System," by Clifford Parrish, of Texas Technological College; "A Uniform and Equitable Method of Valuation," by Ray Goodson, of Southern Methodist University; "A Brief Study of 1940 Floods in the Coastal Plains Area of Texas," by Morris Fry, of the University of Texas; and "Hole Surveying," by J. R. Sims, of Rice Institute.

The customary breakfast sponsored by the Section for the Student Chapter members was held Saturday morning, with 45 students present. After individual introductions, E. L. Myers announced the winners of the contest held the day before and H. N. Roberts, president of the Texas Section, awarded to each of the winners his check. First prize of $25 went to Mr. Goodson; second prize of $15 to Mr. Fry; and third prize of $10 to Mr. Sims.

During the business session that took place later in the morning the following conference officers for 1941–1942 were introduced: Arnold Maeker, of Texas Technological College, chairman; Norman Hueni, of Rice Institute, vice-chairman; and Frank Manning, of Southern Methodist University, secretary-treasurer. There was also a discussion on the subject of "The Engineer and the Selective Service Act."

Up-State New York—April 19

Thirty-seven delegates from Student Chapters in Up-State New York met at Troy on April 19, as guests of the Rensselaer Polytechnic Institute Chapter. After registering, the delegates—from Clarkson College, Cornell University, Union College, and Syracuse University—were conducted through the soil mechanics, photogrammetry, and materials testing laboratories. Seniors who were working on their theses explained their projects. A tour of the W. L. and E. Gurley Instrument Company completed the morning program. The latter inspection trip proved especially interesting as the whole process of fabrication and assembly takes place at the one location.

Some of the problems confronting the various Student Chapters were discussed by the Chapter secretaries at the business meeting following luncheon. The annual student prize competition then took place. Those participating were M. Cain, of Clarkson College, whose topic was the St. Lawrence Seaway; D. A. Collin, of Union College, who read a paper on the Pennsylvania Turnpike; and N. Bassar, of Rensselaer Polytechnic Institute, whose paper was on "Floating Roofs for Oil Tanks." A committee consisting of E. H. Sargent and Professors H. H. Nugent and A. D. Hoadly then awarded the prize to Mr. Cain. The prize, donated by the Mohawk-Hudson Section of the Society, consists of junior membership in the Society. A film showing the failure of the Tacoma Bridge completed the program.

An Official Language for Soil Mechanics

Perhaps no activity of the Society has greater importance than the orderly rearrangement of material scattered helter-skelter in the vast tool-box of the civil engineer. Manuals of Engineering Practice were introduced in 1927 as a Society activity in order to assemble, progressively, the proved truths developed from time to time in the various sectors of the engineering profession.

In the relatively new field of soil mechanics, it is especially important to establish a point of practical contact between theory and practice. As a preliminary step in this direction, the early appearance of a guide for standard letter symbols should prove of long-time value. Within a few days every member of the Society will receive his free copy of Manual of Engineering Practice No. 22, on "Soil Mechanics Nomenclature." This manual is divided into two sections or chapters. The first, an arrangement of symbols in alphabetical order, is followed by a series of definitions segregated in specialty groups (such as, "Terms Relating to Stress, Strain, and Displacement," etc.) for ease of reference.

A sister manual in the series on soil mechanics is Manual 18, "Selected Bibliography on Soil Mechanics," published last year.

Manual 22 is the product of a group appointed in 1936 as a Division Committee on "Glossary of Terms and Definitions, and on Soil Classification." The original committee was made up of Harry Englander, Glennon T. Gilboy, William S. Housel, and Robert V. Labarre, with William T. Kimball as chairman. William L. Shannon was added to the committee in 1938.

In order to obtain the broadest possible representation of engineering opinion, in 1938 the committee mailed a list of soil mechanics terms requiring definition to more than eight hundred engineers selected on the basis of their participation in foundation work and allied fields. At the same time, a list of symbols, prepared for the committee by Arthur Casagrande, Assoc. M. Am. Soc. C.E., was sent to sixty engineers selected for their experience in the preparation of soil mechanics manuscripts and for their familiarity with soil mechanics literature. The responses to these first lists were used as a basis for subsequent questionnaires, and in the fall of 1938 a second questionnaire was mailed to one hundred and fifty engineers who had indicated their interest in the work of the committee. Since that time, several revised lists have been developed and subjected to the criticism of about thirty of the most representative and best qualified engineers. The original questionnaire was sent to all members of the Soil Mechanics and Foundations Division of the Society and to a wide representation of the American Society for Testing Materials (A.S.T.M.), the American Association of State Highway Officials (A.A.S.H.O.), American Standards Association (A.S.A.), engineering institutions, soil laboratories, governmental agencies, and designing and construction engineers. Throughout the period of study the A.S.T.M. Subcommittee on Terms and Definitions of Committee D-18 on Soils for Engineering Purposes has cooperated in the work.

In addition to Prof. Casagrande, the following engineers have given valuable aid to the committee in its work on notation: E. R. Fadum, Jun. Am. Soc. C.E.; M. J. Hvorslev, Assoc. M. Am. Soc. C.E.; and D. W. Taylor, Assoc. M. Am. Soc. C.E.

This instrument for standardization, in the hands of engineers engaged in the art of soil mechanics, should do much to promote uniformity and simplicity in future developments in this field.

Biographical and Professional Records

NEARLY 7,000 biographical and professional records of Society members have been received at Headquarters since April 11, 1941, when request was made that these records be brought up to date. As rapidly as possible these records are being classified and indexed by name and under major engineering specialties, and placed on file where they will be available for many restricted uses.

Newly elected members or those who had supplied biographical information during the prior 18 months were not solicited, as the information now in hand is considered sufficient for the present.

On request to Society Headquarters, a replacement copy of the record form will be sent to those members who may have misplaced the original. If you have received your copy and have not yet filled it out, it will be appreciated if you will do so at your earliest convenience. It is to the distinct advantage of every member to have this information on file at Society Headquarters.

Local Sections Publish Yearbooks

A NUMBER of the Local Sections of the Society issue yearbooks, ordinarily every spring. These volumes are valuable for reference, particularly to the Section members themselves. Recently there have come to Headquarters two especially good examples of such Section publications. These are from the Philadelphia and San Francisco Sections.

Both are pocket size and have many features in common. Each gives an alphabetical list of members and full information on the Section's committee work. Of course the constitution is also included. Then there are a number of items covering Section activities. In addition, the San Francisco yearbook incorporates a few pages of abstracts from the more important technical papers presented during the year.

Although these yearbooks come from two of the larger Sections, the same idea might be followed to advantage by others, perhaps on a more modest scale. The extent of treatment, and correspondingly the cost, would be in proportion to the size of the Section and the scope of its work. Even a mimeographed pamphlet, at moderate expense, would serve. For local use such a publication is more convenient than the bulkier Society Yearbook. All the Sections that follow this practice are to be congratulated on their progressiveness.

Winsor Memorial Dedicated

ABOUT two hundred relatives and engineer friends of the late Frank E. Winsor, M. Am. Soc. C.E., gathered at Quabbin Reservoir on Tuesday morning, June 17, to render one more significant tribute to a great engineer. His widow and brothers were there, his children and grandchildren. But the great number were drawn simply by ties of friendship and devotion to one who through a long and active life never lost an opportunity to give expression to these same attributes.

A fine memorial was unveiled to his memory. It was emphasized that no official appropriation had brought this into being—no society, no organization, no commission was officially responsible. It was purely and simply a spontaneous expression on the part of engineers and friends.

In keeping with Mr. Winsor's own character, the ceremonies were simple but dignified. The presentation address was by Secretary George T. Seabury, lifelong friend and associate. Then came the unveiling by Mr. Winsor's grandson, Edward Winsor. In a few words Governor Leverett Saltonstall of Massachusetts accepted the memorial. Finally, Eugene C. Hultman, chairman of the Metropolitan District Water Supply Commission, gave his tribute from the standpoint of the organization Mr. Winsor served so faithfully and so well. There followed a luncheon in the administration building across the reservoir, and then the large party in automobiles returned to Boston by a circuitous route to view many of the important features of the 73-million-dollar engineering project.

Passing Winsor Dam on the east end, many engineers will thrill as they pause at the Winsor Memorial. It is on an eminence overlooking the now partly filled Quabbin Reservoir. In the background are the Massachusetts hills and closer at hand Winsor Dam itself, one of the great structures raised under Mr. Winsor's supervision.

On the nearer side of the memorial a bas relief in bronze depicts a profile view of Mr. Winsor holding a sheet of engineering plans. Near the inscription appear the emblems of the Boston Society of Civil Engineers and the American Society of Civil Engineers, two organizations with which he was closely associated as member and officer for most of his active lifetime. Presiding at the ceremony was Arthur D. Weston, M. Am. Soc.C.E., chairman of the committee for the memorial. Francis H. Kingsbury, M. Am. Soc. C.E., was secretary and treasurer.

Long may this memorial stand in eloquent tribute to a sterling citizen, a loyal friend, and a great engineer!

WINSOR MEMORIAL OVERLOOKS QUABBIN RESERVOIR AND (LEFT) ITS NAMESAKE, WINSOR DAM

Honorary Member Reports from a Besieged City

A letter recently received by the Society from one of its members in London—the Hon. W. J. E. Binnie, Hon. M. Am. Soc. C.E.—will be of interest to readers of "Civil Engineering." The following excerpts tell their own story.

"NO DOUBT you hear a good deal about our sufferings in England from the persistent bombing to which we are subjected. At first we were very apprehensive, but as time went on and the colossal devastation which was promised us by Goering did not eventuate, thanks to our airmen, we all settled down to it and shall quite miss the 'blitz' when the war is over! Last week the casualties to date were published here—only 29,000 killed and about 40,000 seriously injured—which I understand is less than the annual carnage by motor traffic on the roads of the United States.

"We have, however, lost a number of beautiful old buildings, such as the Hall where the *Midsummer Night's Dream* was first played in Elizabeth's day; the Guildhall, the Plantagenet walls of which are still standing; the beautiful Coventry Cathedral, an absolute ruin except for the spire.

"Early last year I went out to Hong Kong for the Crown Agents for the Colonies to investigate a proposal for a new source of water supply and then flew to Rangoon to visit works under construction for the water supply of that city, leaving by an 'Air France' plane for England on June 9th. Our route home passed through Libya, and while we were flying from Calcutta to Damascus we heard that Italy had declared war, so that route was impossible. We reached Damascus, then flew to Cairo for instructions, and were sent up to Khartoum and then across the desert to Fort Lami just south of Lake Chad in Central Africa. From there we took a northerly course, finally landing at Algiers to hear that the French had thrown up the sponge and it seemed that we could get no further. I managed, however, to escape at last by serving as 'pantryman' to a Chinese cook on a filthy little 1,800-ton collier, and thus reached Gibraltar, where I was finally picked up by the *Viceroy of India* which called there to take off refugees. I can therefore claim to be the first Honorary Member of the Society whose professional career includes washing up dishes!"

Employment and Earnings in the Engineering Profession, 1929 to 1934

Herewith is quoted verbatim the summary chapter of Bulletin No. 682 of the U.S. Bureau of Labor Statistics. The study of the engineering profession was carried out by the Bureau with the assistance of the Society and other organizations and upon request of American Engineering Council. This summary supplements previous extensive reports on the results of the survey in these columns. The whole 250-page Bulletin may be obtained from the Superintendent of Documents, Washington, D.C., at a price of 25 cents.

Summary

THIS REPORT on employment and earnings of professional engineers deals with information collected in 1935 by the Bureau of Labor Statistics, at the request of American Engineering Council, in order to determine the effects of the depression upon professional engineers during the period 1930–1934.

Scope and Method

The data were collected by means of a mail questionnaire, a copy of which was sent to each of 173,151 professional engineers. This list may be considered as representative of every phase of professional engineering activity, in that it was compiled through the cooperation of most of the engineering societies in the country, with additional names furnished by 32 state boards of engineering examiners and the deans of 156 engineering schools. The net number of usable returns was 52,589, or 30.4% of the original mailing list.

The 52,589 returns embraced 33,841 older engineers who reported that they were professionally active prior to 1930. The remaining 18,748 returns included younger engineers who had entered the profession in the period 1930–1934.

The 33,841 returns from the older engineers averaged 15% of the 226,136 technical engineers reported in the 1930 census. On a regional basis, and separately for four groupings of professional classes, the age composition of the returns closely approximated the 1930 census data. Comparison of the 18,748 returns from younger professional engineers, which covered primarily men with first degrees in engineering, with the corresponding Office of Education data for the period 1930–1934 shows that approximately 32% of all such engineers furnished information to the Bureau.

The two parts of the sample obtained in this survey can be considered as representative of all professional engineers in the country.

The Growth of the Engineering Profession, 1910 to 1934

To understand better the problems faced by the profession in the period 1930–1934, special consideration was given to the growth of the profession. This analysis shows: that for the decade 1910–1919, the census indicates an absolute increase in technical engineers from 88,744 to 136,080, or 53.3%. In the decade 1920–1929 the increase was from 136,080 to 226,136, or 66.2%. From 1930 to 1934, reports made in the present survey indicate a growth of 26.4%, or in absolute numbers in the sample from 33,841 in 1929 to 42,787 in 1934. Despite similarity in annual influx, the data reveal that the rate of increase of technically trained engineers during the depression was slightly less than it had been in the decade of the 1920's. For the latter period, the compound rate of growth apparently was $5^1/_4$% per year as against a compound rate of growth of $4^3/_4$% per year in the period 1930–1934.

Further comparison of the two periods shows a marked change in the source of supply of engineers. In the depression years the colleges were supplying as many engineers with degrees as were supplied in the 1920's from all sources. In the 1920's, a substantial number of entrants to the profession were non-graduates with an incomplete college course. This raising of educational standards appears to be definitely related to the change in the relationship of the demand for professional services to the supply of trained engineers.

Educational Qualifications of Professional Engineers

Although the reports in the survey embraced a substantial number of men who had obtained professional engineering status without formal engineering education, analysis reveals that a first degree in engineering is almost a prerequisite to obtaining professional status. Insistence upon rigid engineering education as a prerequisite to engineering experience is further evidenced by the fact that all but a very small proportion of the agricultural, ceramic, and chemical engineers had college degrees. However, as many as 17.3% of the civil engineers were not college graduates.

Employment in the Engineering Profession, 1929 to 1934

Supply and demand for engineering services, 1929 to 1934.—Over the 5-year period ending December 1934, the number of persons in, or trained for, the engineering profession increased by 25.3%. On the other hand, opportunities for engineering employment increased only 4.4%. The result was a large amount of unemployment and intense pressure to find non-engineering work. Thus, the proportion of engineers engaged in non-engineering employments increased from 6.3% in 1929 to 14.1% in 1934. The proportion unemployed increased from 0.7 to 8.5%.

Had it not been for the large increase in the employment of engineers by public authorities, the effect of the depression on the profession would have been even more disastrous. Thus, private engineering employment decreased by 11.8% from 1929 to 1932, and despite some increase from 1932 to 1934, it was still 8.2% below the 1929 level at the end of the 5-year period 1930–1934. On the other hand, there was a 46.8% expansion in public employment of engineers. The absolute increase reported in private engineering employment between December 1932 and December 1934 was only half of that obtaining in engineering employment with public authorities. Relative to the number so employed in 1932, the rate of increase in public engineering employment was almost five times as great as that in private engineering employment.

Over the period 1930–1934 the increase in the number of engineers among the several professional classes ranged from 17.6% for mining and metallurgical to 62.5% in the case of chemical and ceramic engineers, but in no professional class did total engineering employment keep pace with the growing number of engineers. Furthermore, the opportunities for private engineering employment differed markedly among the professional classes. Thus, over the 5-year period, private engineering employment increased by more than a third for chemical and ceramic engineers. Employment of electrical, mining and metallurgical, and mechanical and industrial engineers remained relatively constant. In the case of the civil engineers, there was a decrease of about one-third in private engineering employment.

All professional classes participated in the increases in employment of engineers by public authorities. The sharpest increases occurred in the period 1932–1934. The most pronounced increase occurred among civil engineers. The proportion of this group employed by public authorities increased from 40.0% in 1929 to 48.5 in 1934.

In 1929 private engineering furnished by far the greatest employment for engineers. For civil engineers this covered 54.3%. There was a range of from 80.6 to 87.3% among the other four professional classes. By December 1932 private engineering among civil engineers had dropped to 37.6% and by December 1934 to 31.8%.

Non-engineering employment increased sharply from 1929 to 1932 and in equal measure for all professional classes, absorbing many more engineers than did public engineering, in which employment also increased. But despite the fact that the proportions of all engineers in non-engineering employment rose from 6.3% in 1929 to 12.0% in 1932, there was an even larger increase in unemployment. This situation was common to all professional classes. Between December 1932 and December 1934 there were further increases in non-engineering employment for all professional classes, although the increases were not so great as between 1929 and 1932. Unemployment declined for all professional classes, except for civil engineers.

Of all engineers who reported as being professionally active prior to 1930, only 46.2% were in the employ of private firms in 1934; in 1929, 62.2% were so engaged. Federal Government employment provided for 10.1% in December 1934; in 1929, this field gave employment to only 5.3%.

Over the period 1930–1934 there was a remarkable stability in the number of engineers classified as independent consultants, and those engineers engaged in the teaching of engineering subjects.

This was also the case for those in the employ of state, county, municipal, and other public authorities, especially if considered together.

Despite the fact that 5,003, or 16%, of the reporting engineers active in the profession before 1930 suffered a loss of private engineering employment by 1934, some 3,112, or 18%, of the new entrants found engineering work with private firms. The increase in public engineering employment was shared by both older and younger engineers.

Employment in relation to engineering experience.—Analysis of the employment data in relation to advancing age and experience shows that private engineering predominates as a first field of employment for recent graduates. With advancing age, the decline in the proportions so reporting was very marked indeed.

For civil engineers, public engineering employment follows in importance after private engineering employment as first fields of employment opportunity. By contrast, the two most important sources of employment after private firms for recent graduates in the other professional classes were teaching and non-engineering.

Among all professional classes, both state and county government employment and that with municipal and other public authorities constituted both training grounds and fields of final employment. By contrast, Federal Government employment was virtually a field of final employment or one suited for men with years of experience.

Independent consulting was practically non-existent as a type of employment for recent graduates.

Employment in relation to type of education.—Engineers, irrespective of the type of education they have received, are overwhelmingly dependent upon private industry for employment. Only among postgraduates did private firms employ as little as one-half. For first-degree engineering graduates, state and county work followed in importance after private-firm employment (7.3%). This proportion differed but slightly from those reporting non-engineering work or employment with municipal and other public authorities.

Articles in "Civil Engineering" Giving Results of Survey of Engineering Profession by U.S. Bureau of Labor Statistics

1. *"The Education of the Engineer," August 1936, page 539*
2. *"Unemployment in the Engineering Profession," February 1937, page 145*
3. *"Employment in the Engineering Profession, 1929 to 1934," May 1937, page 359*
4. *"Security of Employment in the Engineering Profession," June 1937, page 426*
5. *"Income and Earnings in the Engineering Profession, 1929–1934," September 1937, page 655*
6. *"Monthly Earnings of Professional Engineers, 1929–1934," December 1937, page 875*
7. *"Sources of Income in the Engineering Profession, 1929 to 1934," April 1938, page 290*

Among those with postgraduate training, no less than 29.4% were engaged in teaching. Of the 1,729 engineers engaged in the teaching of engineering subjects, 60.7% were first-degree engineering graduates and 31.8% were postgraduates.

The analysis makes it evident that experience and not education was the important criterion for entry into independent consulting work.

Civil engineers predominate in the construction fields of private industry and public employment, while their opportunities in other fields were very low. Thus, in manufacturing only 5.4% of their older engineers were so employed, in public utilities 3.8%, in extractive industries 2.7%, and in transportation 4.3%. The 6.9% reporting in personal service was relatively the lowest of the five professional classes.

Types of engineering work.—Consideration of the distributions of engineers by types of engineering work shows that civil engineers predominate in construction and that this is the predominant type of work for civil engineers. For all other classes of engineers the most important type of employment was "operation"—production, maintenance, etc., under supervision. The next most important type of employment was design and research.

Sales work is more important as a source of employment to electrical and mechanical and industrial engineers than to other classes of engineers.

As would be expected, general administration and management covered a higher proportion of younger mechanical and industrial engineers than are reported by any other professional class. Among the older engineers reporting, however, there was little difference between the various classes in the proportions so engaged.

Consulting and teaching both presented the same characteristics. First, they did not offer a wide range of employment to younger engineers, and second, there was a close similarity in the proportions of all older engineers engaged in these two types of work.

Conditions of Employment in the Engineering Profession

Analysis of reports furnished by engineers in engineering work in December 1934 shows that 68.4% of all professional engineers used personal contacts and recommendations to obtain their jobs. Those who used this medium, together with those who obtained their positions through the civil service, formed nearly four-fifths of all reporting.

The degree of economic security among professional engineers, as evidenced by possession of an employment contract covering some period of time, or by pension privileges, was negligible.

Unemployment in the Engineering Profession, 1929 to 1934

Unemployment at end of 1929, 1932, and 1934.—Between the ends of 1929 and 1932, the percentage of engineers who were unemployed increased from 0.7 to 10.1. At the end of 1934 the percentage was 8.5. There was slight variation in the proportions of unemployment among the various professional groups for each of the three periods. Thus, in 1932, the range was from 8.6% for the chemical and ceramic engineers to 10.7 for mechanical and industrial engineers. In 1929, while 2.0% of the mining and metallurgical engineers reported unemployment, the range for the remaining professional classes was only from 0.5 to 0.7%. So also in 1934 there is a narrow range for all professional groups, except civil engineers. In their case the proportion unemployed increased from 10.0 to 10.2%.

As of December 31, 1929, the percentage range of unemployment was from 0.4, in the case of the youngest engineers, to 1.9 for engineers 48 years and over. By December 1932 unemployment had increased markedly for all age groups. Unemployment was least (8.0% of the total) for engineers 31 to 40 years of age in 1932 (33 to 42 years of age in 1934); it rose, however, to 10.9% among the oldest engineers, those over 50 years of age in 1932.

By December 1934 many of the older engineers were still unable to obtain work, and there is a very strong presumption that the preference in new hirings was given to the younger men. Thus, unemployment among those who graduated from 1925 to 1929 was cut from 10.6% in December 1932 to 7.0% in December 1934. Declines also occurred between these periods among those who had graduated from 1930 to 1932, and those 41 to 50 years of age in 1932. But the proportion of those over 50 in 1932 reporting unemployment rose from 10.9% in December 1932 to 11.5% in December 1934.

Among the several professional classes, with the possible exception of chemical engineers, unemployment at all three dates was higher for those who were 53 years of age or over in 1934 than for the younger men who entered the profession in the period 1925–1929.

Incidence of unemployment, 1930 to 1934, inclusive.—More than 34% of all the engineers reporting were unemployed at one time or another in the period 1930–1934, as against about 10% who were unemployed on December 31, 1932. For all graduates 33.9% experienced unemployment. This percentage differs but slightly from the general average of 35.4 and 35.6%, respectively, for engineers who did not complete a college course and for engineers with a non-collegiate technical-school training.

In all professional groups there appeared an age beyond which there was apparently a common risk of unemployment. For civil engineers it was 43 years of age, whereas for electrical, and mechanical and industrial engineers it occurred after 33 years of age. There appears to have been no greater incidence of unemployment among the engineers 53 years of age and over than there was among those 43 to 52 years of age.

At all ages, civil engineering showed the greatest extent of unemployment. Thus, of this group graduating in 1930 to 1932

59.7% reported unemployment at some time during the 5 years covered. The next highest percentage, 54.7, was found among electrical and mining and metallurgical engineers. Among civil engineers graduating prior to 1914, approximately 27% reported unemployment, whereas approximately 24% of the mechanical and industrial engineers, and mining and metallurgical engineers so reported.

Periods of unemployment, 1930 to 1934, inclusive.—For the country as a whole, the median period of unemployment for engineers who were college graduates was 12.2 months. For engineers who did not complete their college course it was 16.3 months, and for those with a non-collegiate technical-school training, it was 17.3 months.

The average length of the period of unemployment increased with age. When the older engineers became unemployed, unemployment lasted longer than it did with the younger engineers. Thus, the median period of unemployment for engineers graduating in 1925–1929 was 12.1 months, whereas the median for those graduating prior to 1905 was 23.1 months.

This rapid increase in the length of the average period of unemployment holds also with reference to all of the separate professional classifications. In the case of electrical engineers, the average rose from 14.1 months for those men 33 to 42 years of age to 25.3 months for those who were over 53 years of age. For mechanical and industrial engineers, the increase was from 15.2 to 22.2 months, and in the case of civil engineers from 12.9 to 22.9 months.

The influence of regional location on unemployment was practically negligible, whether considered from the point of view of differences in incidence or of severity of unemployment.

Public relief among professional engineers, 1929 to 1934.—At no time was direct relief extensive among professional engineers, but the development of work-relief programs after 1932 was important. In fact relief work on work-relief projects was the main source of assistance to those who remained unemployed. Thus, on December 31, 1932, when slightly more than 10% of the engineers were unemployed, only 0.7% were on work relief. Two years later nearly 5% of all engineers were on work relief, which was approximately half of the total number of engineers unemployed at that time.

The reports for December 31, 1934, show striking differences in the extent of work relief as between civil engineers and the other professional classes. At that time 6.2% of all civil, agricultural, and architectural engineers were on work relief as compared with only 2.2% of all the other professional classes combined.

Among engineers with an incomplete college course, 19.6% of the civil-engineer group reported some work relief, whereas only 7.5% of those in the other professions considered together so reported. Among college graduates, work relief was reported by 16.8% of the civil-engineer group and by only 10.9% of the mining and metallurgical engineers. For the other professional classes, the percentages were 8.3 for both electrical and mechanical and industrial engineers, and 6.6 for chemical and ceramic engineers.

In all professional classes, age was an important factor in the frequency of work relief. Thus, there was relatively little difference as regards the frequency of work-relief experience between those graduating in 1930–1932 and those graduating in 1933–1934. By contrast, the percentage of civil engineers and electrical engineers who reported work relief was only half as large among those graduating prior to 1915 as among those graduating in 1930 or later years.

The median period of work relief was approximately 5 months. Essentially, the periods were the same for both civil engineers and mechanical engineers, though the average period was perhaps shorter in the case of electrical engineers. In more than four-fifths of the cases, those who reported a period of work relief also reported a period of unemployment.

Earned Annual Incomes of Professional Engineers, 1929 to 1934

(Earned Annual Incomes from All Sources in 1929, 1932, and 1934)

Incomes of engineers without regard to age.—In 1929, 50% of the 30,032 reporting engineers earned more than \$3,412, and 50% earned less than that amount. Twenty-five per cent earned more than \$5,012, and 10% had incomes in excess of \$7,466 per annum. On the other hand, 25 and 10% of the engineers earned, respectively, less than \$2,509 and \$1,878 per year.

Also in 1929 and without regard to the age distributions of the different classes, 10% of the mining and metallurgical engineers earned more than \$9,912 per year, chemical and ceramic engineers ranked second with 10% earning more than \$9,103, and were followed in order by mechanical and industrial engineers (\$8,508), electrical engineers (\$7,185), and civil engineers (\$6,507). At the upper 25% level, mining and metallurgical engineers reported earnings of \$6,301 per year, and those of the other professional classes ranged from 4% lower for chemical and ceramic engineers to 28% lower for civil engineers. This order of professional classes was also maintained in 1932 and 1934.

Between 1929 and 1934 the median earnings of all engineers from all sources declined from \$3,412 to \$2,286, or 33.0%. The percentage decrease of the earnings of the highest 10 and 25% was about the same as that noted for the median. On the other hand, in 1934, 10% of the engineers earned less than \$872, a decrease of 53.6% at this income level. Almost two-thirds of these decreases in earned annual income occurred between 1929 and 1932. There were further decreases from 1932 to 1934.

Over the period 1929 to 1934, relatively, the smallest shrinkages in earnings were reported by the civil engineers, while the chemical and ceramic engineers suffered the greatest cuts. The median income of the former group declined 30.2%; of the latter group, 46.2%. The decrease for electrical engineers was 32.3%; for mining and metallurgical engineers it was 34.5%; and for mechanical and industrial engineers, 37.2%.

Annual income related to age, all engineers combined.—Analysis of the income data reported by all engineers in 1929, 1932, and 1934 shows that average earnings advanced with age up to 60 or 65 years of age. The initial periods of exceptionally rapid rise are followed by slower rates of increase. Thus in 1929 the median earnings of those graduating in 1927–1928 were \$2,098 and were \$3,145 among those who graduated in 1921–1924. The average of those who graduated in 1889–1896 (\$4,968) was little higher than the average of the group graduating in 1897–1904. Similar relationships, but with lower average earnings for each age group, prevailed in 1932 and 1934.

The earnings of the upper 10% in each age group advance more rapidly than median earnings. Thus, in 1929, the highest 10% of the engineers 25 years of age earned 45% more than the median engineer of that age. At 44 years the earnings of the upper 10% were 116% greater than the median, and at 60 were 157% greater. On the other hand, the level of earnings of the lowest 10% of the engineers of a given age advances less rapidly than at the median level and reaches a maximum at an earlier age. In 1929, 10% of the 25-year-old engineers earned less than \$1,462, while 10% of those who were 44 earned less than \$2,683.

Even in 1929, in every age group there were some 10% or more of the engineers who earned less than an average engineer who had been out of college 4 years or more. With advancing age, therefore, the spread between the earnings of the most successful and the least successful engineers became greater. This tendency was more pronounced in 1934 than in 1929. Thus, in 1929 the upper 10% of those graduating in 1889–1896 earned more than 5.5 times as much as the lowest 10%. In 1934, when many were unemployed, the upper group averaged 10.7 times as much as the lower.

Comparison of the earnings of engineers of identical ages in 1929 and 1934 shows that the average income of engineers who had been out of college for 2 years declined 43%. The income of those who had been out 5 years declined 35%. For older engineers the decline approximated 30%.

In all but the youngest age groups the earnings of identical graduating classes were lower in 1934 than in 1929. Among the very youngest identical group for whom figures can be shown, the classes of 1927–1928, the tendency for earnings to advance with experience almost exactly offset the tendency of earnings for any given job to decline during the depression.

Annual income and education.—Consideration of the incomes reported by engineers of different educational backgrounds shows that those with a formal engineering education did receive a higher income. The differences in earnings, however, did not accrue in equal measure for all five professional classes.

At the lowest ages, engineers who have achieved professional status after a high-school education enjoy an advantage in earning capacity. At about 28 years of age this initial advantage is lost. The 1929 average earnings of the graduates in various classes of engineering ranged from \$2,725 to \$3,000 per year, and those of

the corresponding "other" or non-graduate group of engineers from $2,430 to $2,650.

With advancing age, the spreads in earnings in favor of the graduates became very marked indeed. For example, at 5, 20, and 37 years after graduation, the earnings of first-degree mechanical and industrial engineers exceeded by $175, $925, and $1,322 per year those of the engineers of the same professional class whose college course was incomplete, and surpassed by $225, $1,160, and $1,815 per year those of engineers with a non-collegiate technical-school education.

Even in the graduate groups there was variation in the increases in earning capacity with age among the several professional classes. Thus, the 1929 earnings of first-degree civil engineers who had been out of college for 5 years were only $2,050 less than the earnings of those who had graduated 30 years before, whereas the corresponding difference for chemical and ceramic engineers was $3,600. The ranges in earnings of the remaining graduate groups fell between those reported by the civil and the chemical and ceramic engineers.

Sources of Earned Annual Income, 1929 to 1934

Annual incomes from engineering and non-engineering work.—In 1929 there was greater spread in the earnings of engineers engaged in non-engineering work than in those obtained from engineering work. Thus, among engineers 40 to 47 years of age, 10% of those engaged in non-engineering earned more than $12,424 and 10% earned less than $2,420 per year. The respective annual incomes of similar proportions of all those engaged in engineering work were $9,815 and $2,705; and of graduates in engineering $10,088 and $2,936.

The age of maximum earning power for engineers arrives more quickly for non-engineering than for engineering work. Thus, at 48 to 55 years of age, those college graduates who stayed in engineering were doing as well as those who had gone into non-engineering work. This was true even at the highest income levels. But despite the fact that in 1929 the tendency was for average annual incomes of engineers engaged in non-engineering to exceed slightly those in engineering work, the opportunities in non-engineering fields did not embrace more than 7% of the total number of engineers in any one age classification.

Over the period 1929–1934 the relationship changed between the jobs engineers took in engineering and non-engineering work. On the whole it appears that in 1929 non-engineering work was an alternative to engineering work, but from 1929 to 1934 many non-engineering jobs were accepted as an alternative to unemployment or work relief.

Those engineers who were able to stay in engineering fared better than those engaged in non-engineering work. Thus, the group of engineers who were engaged in engineering in 1929 when they were 44 years of age averaged $4,562, while the smaller group in engineering in 1934 averaged $3,524.

It was among those newcomers who were trying to force their way into the profession that the greatest fall in annual income from engineering occurred. Thus, average earnings in engineering in 1934, 2 years after graduation, were 37% less than in 1929. The earnings of those who had been out of college 10 years were 31% lower in 1934 than in 1929. At higher ages all groups averaged a decrease of 26%.

Annual incomes of unemployed engineers.—In 1934 almost one-tenth of the engineers were unemployed or on work relief at the end of the year. The low level of earnings of this group during 1934 contributed to lowering the average earnings of all engineers. Thus, of those engineers who were unemployed at the end of 1934 the average earnings for the preceding 12 months of those who were less than 28 years of age ranged from $700 to $950. Engineers of 40 to 50 years averaged $1,350. Only about 10% of the unemployed, even though they were in those ages at which engineering earnings reached a peak, had made as much as $2,000 in the preceding 12 months. Ten per cent made less than $300 a year.

Monthly Earnings of Professional Engineers, 1929 to 1934

One of the most important additions to the earlier data is a clarification of the relationship of engineering entrance rates and rates in succeeding years. Annual data for a class graduating in the middle of the year under consideration are of little significance; monthly rates are significant. Therefore, and directly supplementing what has already been said, it may be noted that 1929 average engineering earnings for the graduating class of 1929 were $149. The average in 1929 for the class of 1927–1928 was $181. The 1934 average entrance rate was $110. The range of rates of earnings embracing four-fifths of the engineers of the class of 1929 in 1929 was $115 to $215. The corresponding range in 1934 was $75 to $149. The upper level of 1934 was the same as the average of 1929.

Thus, from this more exact measure of entrance rates, it is possible to see the extent to which the depression and the pressure for jobs slowed down the rate of increase in earnings from engineering. Thus the average monthly rate received by 1929 graduates in 1929 was $149. In 1932 it was $156 for such of this class as were engaged in engineering and in 1934 was $162. Those of the class of 1932 in engineering averaged $111 in 1932, as against $124 in 1934. It became progressively more difficult to gain valuable experience. In 1929 the group with 1 or 2 years experience averaged $181, while the entrance group averaged $149. In 1932 the corresponding averages were about $135 and $111. In 1934 they were about $120 and $110.

Engineering Earnings Without Regard to Kind of Engineering Employment in 1929, 1932, and 1934

Earnings of all engineers combined, without regard to age.—In 1929, the range in monthly engineering earnings of professional engineers was very great. Some 79 engineers reported earnings of less than $60 per month, while 168 earned more than $1,880 a month. The median monthly earnings of the 28,511 reporters engaged in engineering was $289. One-quarter earned more than $415, while only 10% had earnings greater than $609 a month. Between 1929 and 1934 there were progressive declines in monthly engineering earnings. While the sharpest absolute decreases occurred at the higher levels of earnings, the greatest percentage decreases took place at the lower earnings levels. Almost two-thirds of the decreases occurred between 1929 and 1932.

Monthly earnings by professional class, without regard to age.—Comparison of earnings by professional class, without regard to age and the consequent effect of the varying age distributions, shows that in 1929 the upper 10% of mining and metallurgical engineers (highest at this level) reported earnings of not less than $792 per month as against $515 a month for civil engineers, who were lowest at this level. Next to mining and metallurgical engineers came chemical and ceramic engineers, followed by mechanical and industrial, and electrical engineers. For the upper 25% of the reporting engineers the order of the professional classes was the same, monthly engineering earnings ranging from not less than $372 for civil engineers to not less than $503 a month for mining and metallurgical engineers. At the middle and lower earnings levels, the differences in earning capacities of the 5 professional classes were less marked, although, in each instance, mining and metallurgical engineers and electrical engineers occupied the upper and lower extremes, respectively.

In 1932 and 1934 the order of the professional classes at the two higher earnings levels was essentially the same as that noted for 1929. At the three lower earnings levels shifts occurred in this order in 1929 and there were further shifts in 1932 and 1934.

Earnings related to age, all engineers combined.—On an age basis the 1929 monthly compensation for engineering services of the lowest tenth of reporting engineers was more than twice as high for those in the age group 48 to 55 as for those of 23 years. At the upper 10% earnings level, maximum earnings of $1,050 a month were reached in the sixties. Similarly, at the average and at the upper and lower quarters earnings levels, age 60 was the turning point.

For men of identical ages in 1929, 1932, and 1934 the data reveal that the greatest impact of the depression, as far as engineering earnings were concerned, fell upon men with from 2 to 5 years' experience.

Earnings and education.—Although the 1929 data on engineering earnings reveal an advantage in favor of men who have engineering degrees, this advantage was less clearly defined than was the case with earned annual incomes. However, the extra years of experience which the "other" or non-graduate engineers had while the graduates were in school permitted of their obtaining higher earnings than graduates only up to a point corresponding to 5 years after graduation. Even at 2 years after graduation the differentials in earnings between the two groups were slight. Similarly, at 4 years after graduation, while at the median level graduate earnings ranged from $225 for first-degree electrical engineers to $250 a month for first-degree chemical and ceramic engineers, among the "other" or non-graduate engineers they

ranged from $200 for engineers with secondary-school education to $229 a month for mechanical and industrial engineers with incomplete college courses.

With advancing age there was a considerable advantage in engineering earnings in favor of the graduates. This was an average advantage, however, for there was a distinct variation in the earning capacities among both graduates and "other" or non-graduate engineers. The monthly engineering earnings of graduates continued to increase several years beyond the point of maximum earnings of "other" or non-graduate engineers. The earnings of the latter either remained stable or declined after 53 years of age.

Earnings by kind of engineering employment.—With due allowance for varying proportions of experienced engineers in the several professional classes, it appears that in 1929, and among those engineers in the employ of private firms, mining and metallurgical engineering paid the highest rates for engineering services, followed by chemical and ceramic engineering, mechanical and industrial engineering, civil engineering, and electrical engineering. In the order as stated, the median monthly engineering earnings reported for 1929 were $338, $341, $314, $300, and $276. These relationships held at all levels of earnings with only one significant exception. From 1929 to 1934 there were large decreases in the rates of pay at all earnings levels among engineers in the employ of private firms.

In both 1929 and 1934, there was a marked spread in the earnings in private-firm employment of each professional group. Thus, while the earnings of the upper 10% of reporting civil engineers were 106% greater than the median earnings of the group, the corresponding difference for mining and metallurgical engineers was 135%. For the other three professional classes, the differences were: 111% for electrical engineers, 117% for mechanical and industrial engineers, and 119% for chemical and ceramic engineers.

In 1929 there was a considerable range in earnings opportunities among the various kinds of engineering employment. Thus, while one-half of the engineers in the employ of state and county governments earned not less than $236 a month, the lowest at this earnings level, the highest median monthly earnings of $439 were reported by independent consultants. Intermediate between these median monthly earnings lay teaching ($310), private-firm employment ($301), municipal government and other public authorities ($272), and Federal Government ($264).

The gradation of earnings in 1929 at the two lower earnings levels was the same as that noted for the median. But at the two higher earnings levels private-firm employment exceeded teaching, being second in order after independent consultants, while the earnings of all three public engineering employments were lower in each instance than those of engineers engaged in teaching.

Over the period 1929–1934 there was an especially marked decline in the earnings of independent consultants as compared with the decline in rates for the other kinds of employment. These changes are to be regarded as in large part a measure of underemployment.

In the other kinds of employment, the largest decline (27%) in average rates paid was in private-firm employment. The smallest decline (14%) was in teaching. Average compensation by the Federal Government for engineering services declined 23%, as against 19 and 17%, respectively, for state and county governments, and municipal and other public authorities.

In private-firm employment, in teaching and among engineers employed by municipal and other public authorities, earnings of the upper 10 and 25% declined less than the average; earnings of the lower 10 and 25%, somewhat more than the average. In Federal Government employment, the declines at all but the highest level of earnings were similar to the decline of the average rate.

Separate analysis of the earnings data for older engineers and younger engineers emphasizes the extent to which earnings in 1934 were diluted by the influx of younger engineers. Thus, while consideration of each group of engineers as a whole revealed a greater decline in earnings at the lower levels than at the higher, for the older engineers the four other earnings levels sank in almost exactly the same ratio as the average in the case of private-firm employment, teaching, Federal Government, and state government employment.

Earnings by field of engineering activity.—In general it may be said that at all earnings levels, and among engineers with 5 years or more of experience, state and county employment is at lower rates than federal or municipal. For civil engineers, electrical engineers, and mechanical engineers, public employment averaged less than any of the fields of private employment, except construction.

For example, while civil engineers averaged $234 per month in municipal employment and $232 per month in the private construction industry, in the other fields of private employment the range in monthly earnings was from $248 to $270. By contrast, chemical and ceramic engineers with the Federal Government averaged $300 per month in 1934 as against $296 in private manufacturing industries.

Within the various fields of private employment, average rates in the construction industry are low. Furthermore, in the five fields of private engineering activity and in personal service, chemical and ceramic engineers and mining and metallurgical engineers appear to have a distinct advantage in earnings, whereas among the three other professional classes the differences in the median monthly earnings reported were not very great.

There was less spread in the earnings reported for public employment than those received by engineers in the other fields of engineering activity. For example, while the median earnings of civil engineers in federal employment were $221 a month, at the upper 10% earnings level the earnings received were $375 a month. By contrast, civil engineers in manufacturing received median monthly earnings of $248 a month and $488 a month at the upper 10% level.

Among engineers born in the years 1907–1909 and 1910–1914, the monthly earnings received for public construction work were slightly greater than those received for private construction work. And except for private construction, there was very little difference in the earnings reported by the two groups of younger engineers engaged in public construction and those received in the other fields of engineering activity.

Earnings by type of engineering work.—For engineers with 5 years of experience or more, those engaged in general administration and management were without any important exception the best-paid group. On the average, engineers engaged in general administration make from half again to twice as much as those engaged in design, construction, or operation. For example, mechanical engineers engaged in design and research averaged $228 while those in general administration and management averaged $324 per month.

Consulting, teaching, and sales in all instances average less than administration and generally average more than design, construction, and operation.

In all professional classes, except electrical engineering, higher rates were paid in design and research and in operation than in construction. For example, while civil engineers engaged in construction reported median monthly earnings of $211, members of this same professional class engaged in design and research and in operation received, respectively, $218 and $226 a month.

Mining engineers averaged nearly the same in design and research as in operation. But in the case of both chemical and ceramic engineers and electrical engineers, those engaged in design and research averaged more than those engaged in operation, and at the higher levels of earnings the differences between them were even more marked.

Within each type of work, construction excepted, chemical and ceramic engineers, and mining and metallurgical engineers had the advantage. For example, the former professional class reported median monthly earnings of $285 for design and research; the latter received $262 a month. The range in monthly earnings for the three other professional classes was from $218 to $228.

Due to the variations in spread, these differences in earnings became accentuated at the two higher earnings levels. For example, while mining and metallurgical engineers reported median monthly earnings of $393 for general administration and management, one-quarter received not less than $618 a month and one-tenth not less than $1,028 a month. The corresponding figures for civil engineers engaged in the same type of work were $312, $426, and $587 a month.

Although the spread in earnings for consulting was less than that noted for general administration and management, it was relatively greater than that which occurred in any of the other types of work. The smallest spread occurred in the earnings reported for construction.

The earnings reported by the two groups of younger engineers show that in all types of engineering work younger engineers start with practically the same level of earnings.

Monthly earnings by geographical division.—In 1929, there were persistent differences in the average rates of pay of three types of

engineering. Thus, graduate mechanical engineers in 1929 averaged higher than electrical or civil engineers in all geographical divisions, except the District of Columbia. In all regions, except New England, graduate electrical engineers earned less than graduate civil engineers.

Within the regions the spreads in earnings differ substantially. The differences in rates as between the various regions are not consistent from one group to the next, nor from one year to another.

The earnings of engineers in the Middle Atlantic States and the District of Columbia appear in general to be slightly above those in New England and the East North Central States. This is especially the case among civil engineers. These four regions are generally above the Pacific States and the West South Central States, both of which rank fairly high as regards earnings of civil engineers.

Electrical engineers are as high in the Pacific States as in the East North Central. In 1934, especially, mechanical engineers in the West South Central States ranked as high as electrical engineers as regards average earnings.

In general, the lowest average rates were reported from the Mountain States and the West North Central, though the differences between the averages in these regions and the South Atlantic and East South Central States are not consistent.

Monthly earnings by size of city.—In 1929, there was an extreme range in average earnings among the cities with a population of 400,000 or more from about $280 per month for Los Angeles and Minneapolis and St. Paul to $351 in Pittsburgh. None of the 18 cities of 400,000 or more in 1934, and only two in 1929, had average earnings materially lower than the average in the smaller cities.

By and large, the cities of 400,000 or over appear to pay $200 to $250 more per year in average earnings than cities of 50,000 to 400,000. These in turn average $100 more than cities of 10,000 to 50,000; and these, perhaps $200 more per year than was paid in communities of less than 10,000. A situation similar to that noted for average earnings reported also occurred at the two lower earnings levels.

The concentration of opportunities for higher earnings in the larger cities is fairly well defined at the upper 25% level and more so at the upper 10% earnings level.

In only three of the cities with 400,000 population or more did the upper 10% of the engineers earn less than was earned at this level ($602) in cities of 100,000 to 400,000. In cities with less than 10,000 population, the upper 10% earned $503 or more in 1929. Similar differences obtained in 1934.

Among the younger engineers, there was almost no variation in their earnings by size of city.

Over the period 1929–1934, the earnings at all income levels and for all cities declined. The smallest declines in average earnings were reported for the cities of San Francisco (15%) and Washington, D.C. (14%). But for the remaining cities the decreases ranged from 20% in the case of Los Angeles to as high as 31% for the city of Cincinnati.

Freeman Scholar Describes Visit to Pacific Coast

The following excerpts have been taken from the latest report of Haywood G. Dewey, Jun. Am. Soc. C.E., who is about to complete his year of hydraulic inspection throughout the United States as current Freeman Scholar.

U.S. ENGINEER DEPARTMENT, LOS ANGELES, CALIF.

TO OBTAIN some understanding of the problems involved in controlling floods in the Los Angeles area, considerable time was spent in the U.S. Engineer office and in the field.

To reduce the damage and danger from floods, the U.S. Engineer Department is building flood-control basins in the main streams and tributaries; debris basins on the tributaries; and improving channel capacities by placing concrete lining, straightening, and by stream-lining bridge piers and other obstructions. Such a program involves a great amount of engineering skill and research.

Seven major flood-control basins are proposed, three of which have been completed. These basins are formed by long earth-fill dams provided with outlet works and emergency spillway. By proper regulation during floods, each basin will not only reduce the peak, but will also continually release water into channels below in amounts that will not tax their capacity to safely carry off the water released. The smaller debris basins will trap material carried by the tributary streams to prevent clogging of the channels below. In some cases it is planned to provide for the trapping of debris in the large flood-control basins.

In connection with this program an outdoor hydraulic laboratory has been developed for testing the design of flood spillways, outlet works, and channel improvements. A most convincing demonstration of the effect of streamlining piers to increase channel capacity may be seen in the 1:50 scale model of a reach of the Los Angeles River flowing through the northern part of the city.

CALIFORNIA INSTITUTE OF TECHNOLOGY

The hydraulic laboratory at the California Institute of Technology is divided into the hydraulic machinery and the hydraulic structures laboratory. The former is probably best known for the tests made on the Colorado River Aqueduct pumps and on the pumps for the Grand Coulee Dam. Precision instruments are used for measuring all test elements to within one-tenth of 1%. Heads as high as 1,000 ft may be obtained.

The hydraulic structures laboratory is operated in cooperation with the Soil Conservation Service. The more recent research work involves the development of a standard design for erosion-control drop structures, the transportation of suspended sediment by water, and the investigation of turbulence mixing as a factor in the transportation of sediment in open-channel flow. Research is being conducted on the transportation of sediment in streams. The need for obtaining fundamental knowledge of this phenomenon is being recognized more and more.

Associated more or less with the study of sediment transportation is the problem of density currents in reservoirs. The laboratory has developed a simple but clever apparatus for demonstrating the movement of density currents. A narrow glass-sided flume is blocked at one end with a model dam. In the reservoir behind this dam a sloping false floor has been placed to represent the bottom of a reservoir. By temporarily blocking off a small portion of the far end of the reservoir until the density of this water has been changed by adding crushed ice, sugar, salt, or a silt suspension, and by adding dye, it is readily possible to observe the underflow or overflow of a density current downstream to the dam, see it flow up the face of the dam, and then return upstream. It is interesting to note that very little, if any, mixing occurs between the density current and the clear water above. It is also demonstrated how outlets properly placed and operated in the lower part of the dam may remove this density flow, or actually a sub-layer of suspended silt in the case of a reservoir in nature. This removal of a silt layer has good possibilities for usefulness in the field.

BONNEVILLE DAM AND HYDRAULIC LABORATORY

A trip was made to inspect the Bonneville Dam and hydraulic laboratory. The power house at the dam is now being enlarged to its full capacity of ten units. Whereas it was argued only a few years ago that too much power was being developed, it is now generally agreed that there is not enough power to supply the demands made by national defense. The turbines being installed were previously seen during a visit to the S. Morgan Smith Company last November, but because of precautions taken by the authorities it was impossible to observe the installation of the units.

The hydraulic laboratory is doing work for the Portland Engineer District. Its main problems are concerned with the testing of spillways, outlet works, tunnels, siphons, and navigation locks. The procedure and technique employed are quite similar to those of the U.S. Waterways Experiment Station in Vicksburg.

State Registration Changes

IN APRIL a law went into effect in Delaware setting up state engineering registration. This reduces by one the few remaining states that have so far failed to provide for registration.

As another matter of interest it is announced that the California Board of Registration has found it necessary to resign from membership in the National Council of State Boards of Engineering Examiners. These matters of information are taken from the *Registration Bulletin* of the National Council, of which T. Keith Legaré, M. Am. Soc. C.E., has long been executive secretary.

Past-President Donald H. Sawyer, 1879–1941

ONE of the youngest men ever to have served as President of the Society, Donald Hubbard Sawyer was also one of the youngest to succumb. His death occurred on Saturday, June 21, only a year and a half after his term of office was completed. He had been stricken and rushed to the hospital in Washington, where he died in his sleep. A year or two previously he had been seriously ill; although his friends knew that he had not entirely recovered, his death nevertheless was a great shock.

He was raised and educated in Illinois, and filled some important engineering engagements there during the first decade of the century. Beginning in 1910, he transferred his activities to the Northwest, being partner in the firm of Sawyer Brothers, with work largely in the State of Washington on irrigation and power along with general municipal engineering.

PAST-PRESIDENT DONALD H. SAWYER

During the World War he reached the rank of Colonel in the Construction Division of the Quartermaster Corps. Following this he was on heavy construction work with James Stewart Company, which naturally led to a term of seven years as secretary of the Associated General Contractors of America. Since that time, 1931, he has been employed by the U.S. Government in important offices, as Director of the Federal Employment Stabilization Board, as Director of Procurement and Chief of the Section of Space Control of the U.S. Treasury Department, as President of the U.S. Housing Corporation, and as Chief of the Real Estate Section, Public Buildings Administration.

Colonel Sawyer's great gifts were recognized in his selection as President of the Society for the year 1939. He gave unstintingly of his time to Society matters, including organization and finances. Both he and Mrs. Sawyer were widely known for their numerous contacts with members and Local Sections throughout the country. A host of friends, including many intimates who served with him on the Board of Direction, will deeply mourn his death.

Many, including officers of the Society, paid tribute to him at the services held in the Fort Myer Chapel just outside Washington on Tuesday morning, June 24. Interment followed in Arlington National Cemetery.

News of Local Sections

Scheduled Meetings

INDIANA SECTION—Picnic at Ross Camp, School of Engineering, Purdue University, on July 20, beginning in the morning.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:15 p.m.; dinner meeting of the Junior Forum at Hart's Restaurant on July 9, at 6 p.m.

SAN FRANCISCO SECTION—Dinner meeting of the Junior Forum at the Engineers Club on July 22, at 5:30 p.m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on July 7, at 12:10 p.m.

Recent Activities

BUFFALO SECTION—*April 10 and May 13:* The staff officers of the 4th Brigade and of the 65th and 74th Regiments of the New York Guard were guests of the Section for the April luncheon meeting. A talk on problems of home defense in time of war was the feature of the occasion. This was given by Maj. William T. Colman, of the Air Corps of the U.S. Army, who also showed motion pictures of aerial cannon firing. The May meeting began with an inspection of the erection of the Rainbow Bridge at Niagara Falls, followed by a dinner. The first after-dinner speaker was Reed W. Cady, resident engineer for the Edward P. Lupfer Corporation, who discussed the design of the bridge, the method of making the surveys, and other features of interest in connection with construction. E. L. Durkee, resident engineer for the Bethlehem Steel Corporation on the construction of the bridge, exhibited a scale model of the structure and discussed the method of erection, after which he showed motion pictures of the erecting works. Members of the local engineering societies were guests of the Section.

LOS ANGELES SECTION—*Pasadena, May 14:* On this occasion the members of the Section were entertained at the California Institute of Technology. First on the technical program, Robert T. Knapp, associate professor of hydraulic engineering at the Institute, presented a paper on the subject of "Density Flow in Liquids." Two members of the soil conservation staff at the Institute—Hugh S. Bell and J. P. O'Neill—assisted him in a series of demonstrations. Density flows due to temperature differences, salt and sugar in solution, and fine silt in suspension were illustrated. A motion picture of density flow phenomena in nature concluded that part of the program. Following the showing of another movie—this one on Shasta Dam—Theodor von Karman, professor of aeronautics at the Institute, spoke on the "Causes of the Failure of the Tacoma Narrows Bridge." Dr. von Karman, who served on the board that made a study of the bridge failure, discussed possible ways in which might have been prevented. His talk was illustrated with slides of wind tunnel models.

METROPOLITAN SECTION—*May 21:* An innovation in the form of a "spring frolic" and picnic supper on the campus of New York University preceded the annual meeting of the Section. Later there was a technical session at which Irving V. A. Huie, commissioner of public works of New York, presented an illustrated paper on "The Sewage Disposal Problem of New York City." The other events of the evening included the annual election of officers and the presentation of the Robert Ridgway Prizes (consisting of Junior membership in the Society) to the outstanding senior in each of seven of the Student Chapters in the Metropolitan Area. The new officers are Dean G. Edwards, president; Irving V. A. Huie, vice-president; and Charles E. Trout, treasurer.

MID-SOUTH SECTION—*Little Rock, Ark., May 5 and 6:* There were 178 registered for the two-day spring meeting of the Section, at which a variety of papers on engineering topics was presented. Some of those addressing the technical sessions were Maj. Thomas F. Kern, district engineer for the U.S. Engineer Office at Little Rock, who discussed the general activities of the Little Rock Engineer District; George R. Schneider and Harrison V. Pittman, respectively head of the design section and chief of the operations division of the Little Rock Engineer District, who covered the planning, design, and construction of Nimrod Dam; Ross White, general manager of Brown and Root, Inc., of Austin, Tex., who delivered a paper on the construction of Marshall Ford Dam; H. G. Thomasson, Jr., assistant engineer for the U.S. Geological Survey at Fort Smith, Ark., who spoke on "Equipment and Methods Used in Stream Gaging"; Kyle Engler, assistant professor of civil engineering at the University of Arkansas, whose paper was on the "Large Use of Ground Water for Rice Irrigation in the Grand Prairie Region"; and Nathan T. Veatch, Jr., consulting engineer of Kansas City, who discussed "Engineering Problems in Camp Construction." On the evening of the 5th there was a banquet, at which J. R. Grant, president of Ouachita College, was the principal speaker. Dancing concluded the evening. At noon on the 6th Lt. Col. S. G. Fairchild, executive officer of the Corps Area Service Command of Camp Robinson, addressed a joint luncheon with the Little Rock Engineers Club and the Arkansas Society of Professional Engineers. Following Colonel Fairchild's talk on the details incident to the care and handling of the utilities in a modern Army Divisional Camp, the group departed for a conducted tour of Camp Robinson. Special entertainment provided for the ladies included a bridge luncheon and tour of the beautiful gardens in the vicinity.

PITTSBURGH SECTION—*April 17 and May 21:* Guests at the dinner meeting held in April included Secretary Seabury, Director

Dunnells, and the students attending the North Central Student Chapter Conference. Talks on Society affairs by Messrs. Seabury and Dunnells were followed by an illustrated lecture on the progress of flood control for Pittsburgh. This was given by Lt. Col. L. D. Worsham, district engineer for the U.S. Corps of Engineers at Pittsburgh. The May meeting was sponsored by the Junior Division of the Section, which had arranged a program of Junior papers. R. J. MacConnell, of the U.S. Weather Bureau, read a paper on "Flood Forecasting Procedure on the Upper Ohio River Basin," while J. J. Steinman, of the Carnegie-Illinois Steel Corporation, chose for his topic, "The Control of Reactions in Statically Indeterminate Structures."

SACRAMENTO SECTION: The regular weekly luncheon meetings of the Section held during April and May featured talks on a variety of interesting subjects. At one of these sessions E. A. Bailey, of Sacramento, Calif., described in detail the geological background for the existence of the Tennessee River, pointing out that the continual and repeated folding of the earth's crust in parallel ridges was responsible for the numerous excellent dam sites in the upper drainage basin at points where the streams broke across these ridges. On the occasion of another luncheon Walter Packard, agricultural economist, discussed the violently changing economic condition of the country. He stated that the profit motive alone is no longer capable of keeping the complex machinery of present-day life in motion and pointed to certain projects of the U.S. Bureau of Reclamation as types of production in which the profit motive enters only indirectly, if at all. He believes that more widespread distribution of income among the people is a trend that will tend to solve some of the most difficult of our economic problems. Another interesting talk was by John P. Buwalda, of the California Institute of Technology, who described the known characteristics of earthquake phenomena. Mr. Buwalda stated that earthquakes are bound to continue in the future, and that engineers must recognize this fact in design and construction.

SEATTLE SECTION—*April 28 and May 19:* The Student Chapter at the University of Washington sponsored the April meeting of the Section and arranged for the dinner and program. One of the senior-class students, Norman Dahl, presented a paper entitled "What Is a Structural Member," which had its genesis in an article entitled "An Investigation of Steel Rigid Frames," in the November 1940 issue of PROCEEDINGS. Mr. Dahl did not entirely agree with the findings of the authors of the article and gave his reasons and the results of his own analysis. Then Col. John H. Stutesman discussed "The National Defense Picture." In May there was a large turn-out for a joint dinner meeting with the Tacoma Section. The list of guests included thirty-two members of the Student Chapter at Utah State College, who were on their annual inspection trip to the Pacific Northwest. The program, consisting of a symposium on "Safety and Efficiency of Traffic Movement," was presented by C. E. Fritts, traffic engineer for the Washington State Highway Department, and his assistant, D. Harrold. Mr. Fritts opened the discussion with a description of the movement of 35,000 troops that day from Fort Lewis to Vancouver, Wash., en route to California for the scheduled war maneuvers, and spoke of the effect of this sudden surge of traffic on the ordinary traffic pattern. He then discussed the necessity for roads for adequate national defense, and Mr. Harrold explained some of the methods used in obtaining data necessary for the elimination of danger points in the highway system and for the design and construction of new highways.

SYRACUSE SECTION—*Watertown, N.Y., May 7:* Preceding a joint dinner meeting with the Alumni Association of Clarkson College, the Section and its guests visited the new Army cantonment at Pine Camp. The afternoon trip was supplemented during the evening program by a paper on "The Functions of the Mechanized Division in Modern Warfare," which was given by Maj. Bruce Clarke, division engineer and commanding officer of the 24th Engineers Armored Battalion, 4th Armored Division, at Pine Camp. Other papers on the technical program dealt with the proposed St. Lawrence Project. These were presented by Maurice P. Davidson, trustee for the New York State Power Authority, who discussed the need for the project from the standpoint of defense; and Lt. Col. A. B. Jones, district engineer for the U.S. Engineer Office at Massena, N.Y., who spoke on design and construction features of the project. During the annual meeting the following officers were elected: Cecil S. Camp, president; Arthur H. Emerson, vice-president; and John O. Eichler, secretary-treasurer.

TENNESSEE VALLEY SECTION—*Watts Bar Dam, May 17:* The Chattanooga Sub-Section acted as host for the spring meeting of the Section, which attracted the large attendance of 140 members and 169 guests. In the morning Charles E. Nichols, project design engineer for the Tennessee Valley Authority at Knoxville, read a paper on the "Watts Bar Steam Plant Design." During the noon-day dinner it was announced that two students at the University of Tennessee—W. B. Winn and Jack D. London—had won the Section's annual prize of Junior membership in the Society. Papers on the Watts Bar Dam were then presented by other members of the TVA staff—William B. Allen and James S. Lewis, Jr.—who discussed design and construction features. Inspection trips, covering the new steam plant, dam, lock, and power house, concluded the program.

TEXAS SECTION—*New Braunfels, May 8, 9, and 10:* Those arriving for the annual spring meeting on the 8th were entertained for dinner and the evening by the Servtex Materials Company of New Braunfels. Mayor Sippel greeted the group on the first day of the regular meeting, and President H. N. Roberts responded for the Section. The first paper on the technical program—"Road User vs. Road Builder"—was presented by J. L. Dickson, of the Texas State Highway Department. Then W. H. Mead, chief engineer and general superintendent of the Salt Flat Water Company, Luling, Tex., discussed "Cleaning Underground Pipe Lines in Place." By means of slides and pictures Mr. Mead showed that some 20-in. pipes carrying waste water from the oil fields had accumulated sediment until there was less than an 8-in. hole in the pipe. He then demonstrated the machine for and method of cleaning out these lines. "The Educator's Point of View in Engineering Education" was presented by Gibb Gilchrist, dean of the Agricultural and Mechanical College of Texas. During the general discussion of the subject that followed his presentation, Dr. Karl Terzaghi was called on to outline the engineering-education situation in Europe. Dr. Terzaghi stated that engineering education consists of both teaching and research and stressed the fact that American universities do not permit the faculty enough time for research. The afternoon session was devoted to defense problems, the first paper being presented by Commander L. N. Moeller, Officer in Charge of the U.S. Naval Air Station at Corpus Christi. Commander Moeller outlined the general defense program of the Navy, indicating the rapid expansion of the Navy program. O. H. Koch, consulting engineer of Dallas, Tex., then discussed "Engineering Phases of Camp Bowie," in which he described the many engineering problems involved in the construction of the camp. The final paper—"Problems Involved in the Design and Construction of National Defense Projects"—was given by E. N. Noyes, chief engineer of the 8th Construction Zone of the Quartermaster Corps. The dinner dance, held that evening, featured a local talent program of singing and dancing, and a talk on the subject of improving relations with the Pan-American countries, given by V. M. Ehlers, chief engineer of the State Health Department. The customary breakfast for the Student Chapter members attending the breakfast took place on Saturday morning. The breakfast and other features of the Student Chapter program are reported elsewhere in "Society Affairs." Business discussion occupied the rest of the Saturday session.

WEST VIRGINIA SECTION—*Clarksburg, May 2:* An inspection trip to the Clarksburg Water Plant in the afternoon initiated the program. Before making a tour of the plant the group heard a paper on water softening, presented by S. G. Highland, general manager and senior engineer of the Clarksburg Municipal Water Supply. The automobile trip to the plant afforded an opportunity to view an unusual piece of road construction on Route 50. Following a dinner in the evening, Theodore Bloecher, president of the Section, spoke briefly on national defense, emphasizing the importance of the Committee for Civilian Protection. Other talks were then given by Earnest L. Bailey, state road commissioner; R. P. Davis, Vice-President of the Society and dean of the college of engineering at West Virginia University; and G. P. Boomsliter, professor of mechanics at the University. Mr. Bailey outlined the work of the State Road Commission, while the two latter discussed suspension bridge failure. Motion pictures of the Tacoma Bridge disaster supplemented the talks on bridge failure. During the business meeting it was announced that W. W. Phillips, of West Virginia University, was the recipient of the Section's prize of Junior membership in the Society.

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for August

Loggers' ingenuity combined with sound engineering principles produced the Baird Creek Bridge in Washington State, described by W. J. Ryan in the lead article for August. This bridge, unusual in design, is also distinguished for judicious use of local materials carefully fabricated to form a permanent and durable structure.

Local materials are also used to excellent advantage in the construction of Denison Dam, the largest rolled-fill structure so far undertaken. Frank M. Van Auken, Chief of the Soils Laboratory of the U.S. Engineer Corps at Denison, Tex., tells of design, control testing, and construction methods employed on that project. This paper describing some of the latest methods in earth work is of interest in comparison with "The Study of Earths: An American Tradition," by Francis M. Baron, which is also scheduled for the August issue. Professor Baron, of Yale University, has made a survey of important literature tracing the early beginnings of the science of soil mechanics.

Among other papers is one by C. E. Schwob on the design of sewage treatment plants as it affects the operation and the operator. This paper was the result of a notebook kept over a twelve-year period listing "pet peeves and don't-forgets."

The P. S. O'Shaughnessy article, "Conformity Between Model and Prototype Tests on Madden Dam Spillway," originally scheduled for July but held over because of space limitations, will also be in the August issue, along with a variety of other subjects.

New Civil Service Examination Announced

A new examination for engineering positions with the Government has been announced by the U.S. Civil Service Commission. There are various positions with salaries ranging from $2,600 to $5,600 a year. Applications will be rated as received at the Washington office of the Commission until June 30, 1942. To qualify, applicants must have completed a four-year college course in engineering and have had broad and responsible engineering experience. Under certain conditions additional engineering experience may be substituted for all or part of the education. The maximum age limit is 60.

Engineers qualified in the following specialized fields are particularly needed for the National Defense Program and are urged to file their applications at once: Aeronautical, agricultural, construction, heating and ventilating, mechanical, ordnance, radio, safety, sanitary, structural, and welding.

Prof. N. G. Neare's Column

Conducted by

R. Robinson Rowe, M. Am. Soc. C.E.

"I hope," said the Professor at our July meeting, "that some of you have solved that alphabetical problem posed in May—to find a group of words using all the letters of our alphabet once without repetition."

"I saw a headline in a Fascist newspaper that comes mighty close," announced Richard Jenney. "It read '*MDV Jew Flock Big Quartz Sphynx?*' and covered a caravan tour to the *n*th wonder of the Roman world. I can't explain the '*MDV*' tho."

"Probably left-overs—three innocent letters; but the hard letters are disposed of nicely. Can anyone do better?"

"I'd rearrange that to read, '*BVD Mew Flock Jig Quartz Sphynx*,' " offered Joe Kerr. " '*BVD*' is a word in my vocabulary meaning 'unaware but light and cool.' "

"But it's not in the dictionary," countered Professor Neare. "A nice try, just the same."

"Congress mixed the alphabet into the New Deal; it should enact some more vowels," suggested Joe.

"It's more concerned now to put the *I*'s out of Hitler and Mussolini and restore *E*'s to all ends of Europe. Until the war is over, we'll have to make wise use of the seven we have: *A*, *E*, *I*, *O*, *U*, *W*, and *Y*. If *U* is wedded to *Q*, we have enuf for six words or syllables."

"Only five," argued Joe, "since *W* must be mated polygamously to *A*, *E*, or *O* or degrade into a consonant."

"Not quite always, as you will see from my collection, which is '*Crwth Fjeld Pnyx Quok Vags Zimb*.' Dictate that jabberwocky to your stenographer and see how many times she can type it in 60 seconds.

"Since Puzzler Jenney is here in person tonight, I'm going to ask him to serve as Guest Professor. Give them one of your tough ones, Dick, to keep their minds off the war."

"All right, Noah. I have one that doesn't require much knowledge of the alphabet. All they have to do is find x, the floor area of a modern Hollywood bathroom. The owner abhorred symmetry but embraced numerology. His consulting numerologist said the four sides of the room should be 7, 8, 9, and 10 ft long, but not necessarily in that order. His wife decreed that the room be as roomy as possible. His consulting architect called me into consultation to lay out the floor plan to these specifications. Everybody was happy but the tile contractor. Can you find x by August?"

(Guest Professor Jenney is really Richard Jenney, Assoc. M. Am. Soc. C.E. Joe Kerr is an old fictional friend.)

Post-War Highway Program Being Studied

Already study is being given to a post-war program to utilize productively some of the man power and industrial capacity that will be released from the production of defense goods and weapons. The Inter-Regional Highway Committee, recently appointed by the President of the United States, is to act in an advisory capacity to the Federal Works Administrator. During the summer this committee is studying a system of national highways to be developed during the post-war period.

The committee is composed of seven men, three of whom are members of the Society: Charles H. Purcell, Chief Engineer, California State Highway Department; G. Donald Kennedy, Commissioner of Michigan Highways; and Harland Bartholomew, of St. Louis. The other members are Thomas H. McDonald, U.S. Public Roads Commissioner; Frederick A. Delano, Chairman of the National Resources Planning Board; Bibb Graves, former governor of Alabama and Rexford G. Tugwell, chairman of the New York City Planning Commission.

Engineering Among the Professions?

This incident concerns engineering and the daughter of a well-known Society member. We will call her Margaret. She is a student at a leading woman's college in the East. Recently as one of her regular assignments in sociology, her professor, a man, assigned her the preparation of a paper on the development of some important profession. He even listed suggested professions—the list contained optometry, but not engineering.

As a loyal daughter, steeped in pride of her father's calling, not to say profession, Margaret asked if she could write on engineering. The professor demurred since he "doubted whether engineering had proper organization and legal qualifications, commonly associated with the real professions." In short, he questioned whether it could be considered a true profession. After discussion, he left this question to Margaret, and she quickly decided on the subject of engineering.

During her Easter vacation, her father gathered for her publications on the Founder Societies, the Engineers' Council for Professional Development, and the National Council of State Boards of Engineering Examiners, and related material dealing with the history and professional aspects of engineering. Even the Headquarters staff was called upon for additional data.

The paper was prepared with gratifying results. The professor agreed that

his thoughts on the matter had been clarified and edified; Margaret got an "A" on her paper—a quite unexpected recognition.

The moral of this incident lies in the common understanding of engineering. Here, the professor quickly admitted his misjudgment. But if a well-informed man could be relatively ignorant on this subject, it behooves the profession to bestir itself. The general public will not read 5,000-word papers just to become enlightened.

Congratulations to Margaret!

What Defines the Great Engineer?

MANY definitions of greatness have been advanced. As regards engineering, the following is attributed to Eugene G. Grace, president of the Bethlehem Steel Corporation, who is himself an engineer:

"Thousands of engineers can design bridges, calculate strains and stresses, and draw up specifications for machines, but the great engineer is the man who can tell whether the bridge or the machine should be built at all, where it should be built, and when."

Course in Photoelasticity

To meet the growing interest in photoelasticity, the Department of Mechanical Engineering at Massachusetts Institute of Technology is sponsoring a short summer course (July 28 to August 8) in this method of stress analysis. Registration will be limited, so application for admission should be made at once to the Registrar, Room 3-107, M.I.T., Cambridge, Mass. Address all other inquiries to Dr. W. M. Murray, Room 1-321, M.I.T.

Approved Abbreviations for Engineering Terms

PROVIDING a shorthand of engineering and scientific knowledge, a revised issue of "American Standard Abbreviations for Scientific and Engineering Terms" has recently been announced. This is sponsored by the American Standards Association, with which the Society is working. It has been developed by a group of engineers, editors, and scientists representing many national organizations, among which the various Founder Societies have taken a leading part.

For simplicity this Standard has adopted the elimination of spaces between word combinations or letters, as for example "mgd" for million gallons daily. This also illustrates the tendency toward maximum abbreviation. The Standards also call for the elimination of periods except in cases where the abbreviation spells out a common English word. For example, note that the abbreviation for feet, "ft," has no period although that for inches, "in.," has the period to distinguish it from "in," the preposition. Similarly there is a simplification in the designation of temperature scales, omitting the degree sign (°) so that the expression for the boiling point, 212 F, is reduced to the briefest form.

Many of these abbreviations have been adopted by the Society in its publications. It is to be hoped that engineers will more and more come to utilize the new standard abbreviations. They may be found in a pamphlet (Z10.1-1941), now available at a cost of 35 cents from the American Standards Association, 29 West 39th Street, New York, N.Y.

NEWS OF ENGINEERS

Personal Items About Society Members

To the ever-growing list of members of the Society in the Officers Reserve Corps of the Army and in the U.S. Naval Reserve who have been ordered to active duty may now be added other names. In the former group there are Col. Charles R. Pettis, from head of the department of mathematics at Mississippi State College to Fort Hayes, Columbus, Ohio; Lt. Col. Ernest F. Robinson, from principal engineer for the U.S. Board of Engineers for Rivers and Harbors, Washington, D.C., to assistant department engineer, Corozal, Canal Zone; Lt. Col. William M. Robinson, Jr., from the Public Works Office of the Norfolk Navy Yard, Portsmouth, Va., to officer in charge of construction of a flying school and bombardier base, Valdosta, Ga.; Capt. Gerald H. Hoffman, from instructor in military engineering at the University of Iowa, to Fort McKinley, Rizal, Philippine Islands; and Capt. Virgil O. Powell, from associate hydraulic engineer for the TVA at Knoxville, Tenn., to resident engineer of construction, U.S. Engr. Fortifications Office, Ft. Barrancas, Fla.

Of the U.S. Naval Reserve there are Comdr. R. R. Lukens, from director of coast surveys for the U.S. Coast and Geodetic Survey at Manila, P.I., to Riverside, Calif.; Lt. Comdr. A. A. Ort, from assistant manager for the Haitian American Development Corporation, Cape Haitien, Haiti, to the Bureau of Yards and Docks, Washington, D.C.; Lt. Comdr. H. H. Houk, from principal engineer for the Interdepartmental Engineering Commission of the Civil Aeronautics Administration in Washington, D.C., to duty with the U.S. Navy as engineer on the $40,000,000 air development program in Alaska; Lt. Werner Ammann, from designer for the Bethlehem Steel Company, at Bethlehem, Pa., to the Office of the Supervisor of Shipbuilding, Portland, Ore.; Lt. Walter A. Burke, Jr., from Stamford, Conn., to the Office of the Naval Inspector-of-Ordnance-in Charge, Louisville, Ky.; Lt. Roy M. Harris, from chief engineer for the Washington State Department of Health, to the headquarters of the 13th Naval District, Seattle, Wash.; Lt. Harry F. MacKay, from the U.S. Engineer Office at Portland, Ore., to the U. S. Navy Yard at Bremerton, Wash.; and Lt. William T. Wright, from chief engineer for Kistner, Curtis and Wright, of San Diego and Los Angeles, Calif., to the district office of the Civil Engineer Corps at San Diego.

EDWARD E. WALL has resigned as director of public utilities for the City of St. Louis, Mo., after almost fifty years in the service of the city. Mr. Wall, who is an Honorary Member of the Society, will be succeeded by MAX H. DOYNE, head of the engineering firm of C. E. Smith and Company, of St. Louis. The latter has been retained by the city in many public utility rate cases.

PATRICK QUILTY has been promoted to the position of commissioner of the New York City Department of Water Supply, Gas, and Electricity to fill the vacancy caused by the death of the late JOSEPH GOODMAN. Mr. Quilty was formerly chief engineer of the Department.

EDWARD J. DOUGHERTY is now president of the E. J. Dougherty Construction Company, with headquarters in Baltimore, Md. He formerly served the Empire Construction Company of the same city in a similar capacity.

PERCY A. SEIBERT, general representative of the Braden Copper Company in Santiago, Chile, received on May 14 the decoration of the Order of the Condor of the Andes with the rank of knight commander. The decoration, which was conferred in recognition of outstanding engineering services rendered in Bolivia by Mr. Seibert, was presented by His Excellency Dr. Hernando Siles, the Bolivian Ambassador to Chile, representing the president of Bolivia.

WILLIAM H. CORREALE, who has been deputy commissioner of the New York City Department of Water Supply, Gas, and Electricity, in charge of the Borough of Queens, has been made first deputy commissioner of the Department.

EDWARD C. BOEHM is now president of Edward C. Boehm, Inc., and of the General Appraisal Company. His offices are located in Buffalo, N.Y.

PAUL A. E. FLUX, lieutenant commander, Civil Engineer Corps, U.S. Navy, retired, has been recalled to active duty and assigned as outside superintendent in the public works department at the Boston Navy Yard. Until recently he was assistant highway engineer for the Connecticut State Highway Department.

LYTLE BROWN, major general, Corps of Engineers, U.S. Army, retired, of Franklin, Tenn., has gone to Washington to take up his work as Tennessee's representative for the state's national defense industries at the capital. General Brown was chief of Army Engineers from 1929 to 1933.

CHARLES EDWARD ANDREW has been appointed bridge engineer for the Washington State Highway Department. His principal duties for the present will be in connection with the insurance settlement on the Tacoma Narrows Bridge. Until lately Mr. Andrew was principal consulting engineer for the Washington Toll Bridge Authority.

JOEL B. COX, who has been an engineer for the McBryde Sugar Company at Eleele, Kauai, T.H., since 1923, has been appointed assistant professor of engineering at the University of Hawaii.

Lacey V. Murrow, lieutenant colonel, Air Corps, U.S. Army, recently sailed for Lisbon en route to England, where he will conduct a special study of flight strips and highways under war conditions. Before reporting for active duty Colonel Murrow was director of the Washington State Highway Department.

E. A. Baugh, for the past two years director of public works for the city of Dallas, Tex., is now director of operations for the WPA in Texas.

Edwin H. Marks, brigadier general, Corps of Engineers, U.S. Army, has been relieved of duty as division engineer for the Ohio River Division at Cincinnati and assigned to new duties at Fort Belvoir, Va., where he will train enlisted men in engineer corps work. His successor will be Col. Charles L. Hall, district engineer at New York.

Harold R. Henderson recently resigned as county engineer for Harrison County, Texas, in order to become superintendent of C. F. Gorman and Company, road contractors.

David E. Donley, major, Corps of Engineers, U.S. Army, has been transferred from assignment in the office of the Chief of Ordnance, Washington, D.C., to Assistant to the Commanding Officer, Denver Ordnance Plant, Denver, Colo.

Homer A. Hunter, formerly city engineer of Dallas, Tex., is now acting director of public works at Dallas, Tex., succeeding E. A. Baugh.

John M. R. Fairbairn, who retired in 1938 after serving for twenty years as chief engineer of the Canadian Pacific Railway, has been appointed director of works and buildings for the naval service of Canada's department of national defense. Mr. Fairbairn is an honorary member of the Society.

Charles H. Capen has been given a leave of absence as engineer for the North Jersey District Water Supply Commission in order to accept a temporary civilian engineering post on water supplies and sewer systems with the Quartermaster Corps in the New York and New Jersey area.

J. T. Tucker, formerly engaged in engineering work at Diablo Heights, C.Z., has accepted an appointment as engineer for the North Dakota State Water Conservation Commission.

DECEASED

Claude Hale Birdseye (M. '23) since 1932 chief of the division of engraving and printing of the U.S. Geological Survey, Washington, D.C., died on May 30, 1941, at the age of 63. Much of Colonel Birdseye's career was spent with the Geological Survey, which he served as topographer in charge of Hawaiian Topographic Surveys (1909 to 1913), geographer in charge of the Rocky Mountain Division (1916 to 1917), and chief topographic engineer (1919 to 1929). His most notable achievements include exploring and mapping the area in the vicinity of Kilaueau Volcano, Hawaii, and the summit of Mt. Rainier. He also surveyed the Marble and Grand Canyons of the Colorado, one of the most adventurous explorations ever sponsored by the government in peace time. During the war Colonel Birdseye served overseas on the staff of the chief of Army Artillery.

Josiah Ackerman Briggs (M. '86) retired civil engineer and former chief engineer of the Borough of the Bronx, died in Yonkers, N.Y., on May 27, 1941. Mr. Briggs, who was 88, was responsible for the design and construction of hundreds of miles of sewers and highways and other improvements in the Bronx. From 1887 until 1910, with the exception of four years in private practice, he was in the service of the Borough of the Bronx—for the last eight years of this period as chief engineer. In 1910 he established a consulting practice, which he maintained until his retirement fifteen years ago. Long a member of the Society, Mr. Briggs served as Director from 1901 to 1903.

Robert Henry Ford (M. '28) retired civil engineer of Chicago, Ill., died at his home there on May 27, 1941, at the age of 71. From 1912 until his retirement two years ago, Mr. Ford was with the Chicago, Rock Island and Pacific Railway—successively as engineer of track elevation, principal assistant engineer, assistant chief engineer, and chief engineer. Before going to the Rock Island Lines he had been with the Central Vermont Railway, the Bethel Mountain Railway, and the Missouri Pacific.

Charles Rauch French (Assoc. M. '08) civil engineer (French and Morris), of Kingston, Pa., died on May 12, 1941. Mr. French had been vice-president and engineer for the Herrick Construction Company at Wilkes-Barre, Pa., and had also maintained a contracting practice at Wilkes-Barre. For some years he was connected with Wood and French, of Kingston, the firm name later becoming French and Morris.

Joseph Goodman (M. '16) commissioner of the New York City Department of Water Supply, Gas, and Electricity, died on May 9, 1941. Mr. Goodman, who was 65, was born in Hungary and educated in the United States. He was an instructor at Columbia University and had engaged in private practice before becoming—in 1901—an employee in the old Bureau of Water Supply of the city. Later Mr. Goodman became chief engineer of Water Supply, Gas, and Electricity, and in 1936 was appointed commissioner.

Samuel Hill Lea (M. '97) of Harrisburg, Pa., died on March 28, 1941. Mr. Lea had been state engineer of South Dakota; city engineer of Charlotte, N.C.; and highway engineer at Keyser, W.Va. For some years he was Pennsylvania State Highway Engineer at Harrisburg, and later was assistant resident engineer inspector for the PWA, with headquarters in Philadelphia.

William Curtis Merryman (M. '99) died at his home in Brunswick, Me., on May 30, 1941. Mr. Merryman, who retired in 1937 after thirty-seven years as resident engineer for the Interborough Rapid Transit Company in New York, was 80. While with the I.R.T. he was in charge of the construction of parts of both the Broadway and East Side lines and of several stations. Before starting the subway work he had been assistant city engineer of St. Paul, Minn., and assistant engineer for both the Great Northern and the New York Central and Hudson River railroads.

Raymond Albert Pease (M. '31) civil engineer of Minot, N.Dak., died recently at the age of 52. For some years Mr. Pease was division engineer for the North Dakota State Highway Department. He had also done emergency conservation work at Minot, N.Dak., and had been resident engineer for the PWA at Omaha, Nebr.

Harlan Rowe Robbins (Assoc. M. '32) senior valuation engineer for the California State Board of Equalization, Sacramento, Calif., died suddenly on May 22, 1941, in Los Angeles, where he had gone on a business trip. Mr. Robbins, who was 47, was assistant engineer and land appraiser for the California Railroad Commission from 1920 to 1934. In 1935 he became connected with the State Board of Equalization.

Henry Chandler Robbins (M. '18) architect and engineer (Densmore, Le Clear and Robbins), of Boston, Mass., died on May 6, 1941. He was 64. From 1898 to 1905 Mr. Robbins was chief draftsman in the office of H. L. Warren and Warren, Smith and Briscoe, Boston architects, and from 1905 to 1907 an architect for the American Telephone and Telegraph Company. From the latter year on he was with the architectural and engineering firm of Densmore and Le Clear—first as chief draftsman and then as member of the firm (the firm name being changed later).

Donald Hubbard Sawyer (M. '19) chief of the Real Estate Section of the Public Buildings Administration, died in Washington, D.C., on June 21, 1941, at the age of 61. Colonel Sawyer had served the Society as Director, Vice-President, and President. A brief biography and photograph appear in the Society Affairs section.

Maurice Leonard Shultz (Jun. '36) of Pleasantville, N.J., died recently at Fort Buchanan, San Juan, Puerto Rico, where he was on duty with the U.S. Corps of Engineers. He was 28. Lieutenant Shultz, who was a member of the Reserve Officers Training Corps, was given his commission a few months ago and left the United States on March 22. Earlier he had been engineer foreman for the Construction Quartermaster at Camp Dix,

N.J., and also sales engineer for the Service Supply Corporation, Philadelphia, Pa.

THOMAS ULVAN TAYLOR (M. '01) emeritus dean of engineering at the University of Texas, died at his home in Austin, Tex., on May 28, 1941. Dean Taylor, who was 83, was elected an Honorary Member of the Society in 1939. A brief biographical sketch and photograph appear in the Society Affairs section.

ROBERT SPENCER THOMAS (M. '20) colonel, Corps of Engineers, U.S. Army, Washington, D.C., died at the Army General Hospital in Hot Springs, Ark., on May 11, 1941. Colonel Thomas, who was 57, had spent his entire career in Army service, having been commissioned a second lieutenant upon his graduation from West Point in 1905. He was stationed in many parts of the United States and in the Philippines, his work including road construction and river and harbor improvement. Until shortly before his death he was stationed at the 2d Army Headquarters at Memphis, Tenn.

ROBERT ANDREW THOMPSON (M. '11) consulting engineer of Fort Worth, Tex., died in that city on May 30, 1941, at the age of 72. From 1898 to 1908 Mr. Thompson was chief engineer of the Railroad Commission of Texas; from 1911 to 1913 chief engineer of the Railroad Commission of California; and from 1913 to 1921 in charge of Pacific District railroads for the Bureau of Valuation of the Interstate Commerce Commission. Later he was chief engineer of the Wichita County (Texas) Water Improvement District, and state highway engineer of Texas.

CURTIS MCDONALD TOWNSEND (M. '93) who retired in 1920 after forty years of service in the Corps of Engineers, U.S. Army, died in Ithaca, N.Y., on May 26, 1941. He was 85. Colonel Townsend had been division engineer of the Great Lakes Division of the U.S. Engineer Office and had commanded an engineer battalion in the Philippines and been chief engineer of the Philippine Division. He had also been president of the Mississippi River Division. During the war he commanded the 12th Engineers in service in France, and afterwards was engineer purchasing agent for the A.E.F.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From May 10 to June 9, 1941, Inclusive

ADDITIONS TO MEMBERSHIP

AICHER, JOHN BARRON (Assoc. M. '41), Asst. Civ. Engr., Trojan Powder Co., Hunsicker Bldg., Allentown (Res., 2000 Washington Blvd., Easton), Pa.

ALDRIDGE, LOUIS ROLLINS, JR. (Jun. '40), Asst. Engr., Columbus-Muscogee County Health Dept., Court House (Res., 1508 Nineteenth St.), Columbus, Ga.

ASCARELLI, MARIO (M. '41), Railroad Products Engr., U.S. Steel Export Co., 30 Church St., New York, N.Y.

AUG, GEORGE CHRISTIAN OESTERLE (Assoc. M. '41), Engr., U.S. Engr. Office, Binghamton, N.Y.

BAER, CARL TORVS (Assoc. M. '21), Senior Engr. in chg. of Design, Dept. of Public Works, 306 City Hall (Res., 6003 McCommas Ave.), Dallas, Tex.

BAKER, LLOYD BEALEY (Jun. '40), Junior Engr., U.S. Bureau of Reclamation (Res., 839 Home Ave.), Friant, Calif.

BAUMLE, GILBERT EDWARD (Jun. '40), R.R. 1, Kendallville, Ind.

BOHNER, THEODORE VINCENT (Assoc. M. '41), Instr., Civ. Eng., North Dakota Agri. College, 719 Broadway, Fargo, N.Dak. (Res., Fifty-sixth and Que Sts., Lincoln, Nebr.)

BROOKS, GEORGE RAYMOND (M. '41), City Engr., City Hall (Res., 513 Duff Ave.), Clarksburg, W.Va.

BROOKS, HOUSTON FREDERICK, JR. (Assoc. M. '41), Junior Insp., State Highway Dept., Box 392, Waxahachie (Res., 309 East Baylor, Ennis), Tex.

BROWN, RUSSELL MERRITT (Assoc. M. '41), Structural Designer, Whitman, Requardt & Smith, Edgewood Arsenal, Edgewood, Md. (Res., 285 Walton St. Lemoyne, Pa.)

CAMPBELL, PAUL FREDERICK (Assoc. M. '41), Structural Engr., Rust Eng. Co., Clark Bldg., Pittsburgh, Pa.

CARDWELL, EDWARD CHARLES (Jun. '41), Sales Engr., Water and Sewage Works Sales, Crane Co., 836 South Michigan Ave. (Res., 6258 North Talman Ave.), Chicago, Ill.

CARY, ALLEN STUART (Assoc. M. '41), Asst. Geologist, Chf., Mud Mountain Soils Laboratory, U.S. Engr. Dept., Enumclaw, Wash.

CLARKE, SAMUEL MONTAGUE (M. '41), Care, Greeley & Hansen, 6 North Michigan Ave., Chicago, Ill.

COOK, MILTON FORD (Jun. '41), Junior Engr., U.S. Geological Survey, Box 205, Lebanon, Tenn.

CROCKETT, EDWARD ST. LAWRENCE (Assoc. M. '41), Associate Field Engr., TVA, Cherokee Dam, Jefferson City (Res., Hodges Apartment, Jackson St., Morristown), Tenn.

DAVIDSON, CLIFFORD ARTHUR (Assoc. M. '41), Associate Hydr. Engr., Federal Power Comm., Hurley-Wright Bldg. (Res., 3818 Davis Pl., N.W.), Washington, D.C.

DEEGAN, JOHN WILLIAM (Jun. '41), With War Dept. (Res., 1336 Lawrence St., N.E.), Washington, D.C.

DE JONG, TIM (Assoc. M. '41), County Surveyor, Clatsop County, Courthouse (Res., 718 Fifth St.), Astoria, Ore.

DUNAWAY, PAUL HARRISON (Assoc. M. '41), New Laguna, N.Mex.

ERICKSON, HERBERT BERNARD (Jun. '41), Junior Engr., Dist. Engr., SCS, U.S. Dept. of Agriculture, Culbertson, Mont.

EVANS, THOMAS CHARLTON (Assoc. M. '41), Asst. Civ. Engr., State Public Service Authority (Res., 174 Wappon Rd., Windermere), Charleston, S.C.

FORKERT, CLIFFORD ARTHUR (Jun. '40), Junior Hydr. Engr., International Boundary Comm., San Benito, Tex.

GERBER, SIGMUND IRVIN (Jun. '40), Field Survey Sub-Section Chf., U.S. Engr. Dept., Washington National Airport (Res., 325 Shephard St., N.W.), Washington, D.C.

GIORGI, LUIS (M. '41), Gen. Director, Technical and Financial, Comm. of Hydr. Structures of the River Negro, Washington 317 (Res., Avenida Gral San Martin 3431), Montevideo, Uruguay.

GLACE, IVAN MAXWELL, JR. (Jun. '41), Designing Engr., J. N. Pease & Co., Box 155, Fort Bragg, N.C.

GRAHAM, DONALD MACDIARMID (Jun. '41), 6452 Kimbark Ave., Chicago, Ill.

GREASER, MAYLIN HENRY (Assoc. M. '41), Care, Kingston Trap Rock Co., Kingston, N.J.

TOTAL MEMBERSHIP AS OF JUNE 9, 1941	
Members	5,722
Associate Members	6,660
Corporate Members	12,382
Honorary	33
Juniors	4,584
Affiliates	70
Fellows	1
Total	17,070

GREEN, ARTHUR EDWARD (M. '41), Prin. Bridge Office Engr., State Dept. of Public Works, State Office Bldg. (Res., 148 Whitehall Rd.), Albany, N.Y.

HALEY, JOHN MELVILLE (Jun. '41), Asst. Hydr. Engr., Oregon State College and SCS, Oregon State College, Corvallis, Ore.

HAMMOND, BRADFORD CHAMPION (Jun. '41), With Phelps Dodge Corp., Box 1202, Morenci, Ariz.

HARRISON, RICHARD EDGCOMB (Assoc. M. '41), Estimator, Geo. A. Fuller Co. & Merritt-Chapman & Scott Corp., Naval Air Base, Quonset Point (Res., Wampanoag Circle, Wickford), R.I.

HILL, EDGAR GOODSPEED (M. '41), Vice-Pres., Ford, Bacon & Davis, Inc., 39 Broadway, New York, N.Y.

HUSAR, EMILE (Jun. '41), Junior Engr., Quartermaster Gen., Washington, D. C. (Res., 41 East 7th St., New York, N.Y.)

IRELAND, CARROL BERT (M. '41), City Engr., City Hall (Res., 2615 L Ave.), National City, Calif.

JACKSON, RUEL REAGAN (Assoc. M. '41), Director, Builder Constr. Section, Eng. Div., WPA, 1734 New York Ave., N.W., Washington, D.C.

KEIL, HOWARD WINSTON (Jun. '41), With Drydocks, Inc., Navy Yard, Brooklyn (Res., 1225 Sheridan Ave., New York), N.Y.

KESTER, FREDERICK HENRY (M. '41), Gen. Mgr., The Canadian Bridge Co., Ltd., Box 157, Walkerville, Ont., Canada.

KINTLER, FRANK CYPRIAN (Assoc. M. '41), Asst. Engr., U.S. Engr. Office, Box 1234, Cincinnati, Ohio.

KLOCK, MORGAN BECKER (M. '41), Structural Engr., Eastman Kodak Co., Kodak Park, Rochester, N.Y.

KOPKOWSKI, IGNATIUS MICHAEL (Assoc. M. '41), City Engr., Hamtramck, Mich.

LANE, JOHN ELLISON (Assoc. M. '41), 1214 East 10th St., Brooklyn, N.Y.

LANGDON, PAUL EUGENE (M. '41), (Greeley & Hansen), 6 North Michigan Ave., Room 1700, Chicago, Ill.

LIND, RALPH EDWARD (Assoc. M. '41), Prin. Asst. Engr., Barnard, Godat & Heft, 314 Terminal Station (Res., 6624 Louis XIV St.), New Orleans, La.

MACILVAINE, MEREDITH KIDD (Assoc. M. '41), Chf. Area Engr., Dist. 4, WPA, 15020 Woodward Ave., Detroit, Mich.

MCCARTHY, DANIEL VINCENT (Jun. '41), Associate Engr., U.S. Engrs., Clock Tower, Rock Island, Ill.

MCINTOSH, JOE THOMAS (Jun. '40), 2d Lt., U.S. Army, 14th Engrs., Fort William McKinley, Rizal, Philippine Islands.

MALEY, WILLIAM TRAHEN, JR. (Jun. '41), Detailer, Waddell & Hardesty, 101 Park Ave., New York (Res., 168 Washington St., Freeport), N.Y.

MARTIN, HARRISON AUGUSTUS (M. '41), Capt., Corps. of Engrs., U.S. Army, 150 Broadway, 18th Floor, New York, N.Y.

MARTIN, ROBERT JOSEPH, JR. (Jun. '40), Junior Hydr. Engr., U.S. Geological Survey, 608 Kilmer Press Bldg., Binghamton, N.Y.

MATHIS, PHILIP JACK (Jun. '41), Junior Engr., U.S. Geological Survey, Box 56 (Res., 115 Capitol Ave.), Montgomery, Ala.

MATTHIAS, CARL DOUGLAS (Jun. '41), Junior Engr. (Civ.), U.S. Engr. Dept., 415 Post Office Bldg, Norfolk, Va.

MAYO, RONALD IRA (Jun. '41), Junior Engr., U.S. Geological Survey, 465 Federal Office Bldg., San Francisco, Calif.

MITCHELL, MAX LEIGHTON (Jun. '40), Asst. Engr., C. H. Hurd, 333 North Pennsylvania St., Indianapolis, Ind.

MORGENROTH, DAN ELBERT (Jun. '40), Godfrey, Ill.

MOUSSON, JEAN MARCUS, 2D (M. '41), Hydr. Engr., Safe Harbor Water Power Corp., Lexington Bldg., Baltimore, Md.

NICHOLSON, RICHARD WALTER (Jun. '41), Civ. Engr., Consoer Townsend & Quinlan, 211 West Wacker Drive (Res., 1122 North Lawler Ave.), Chicago, Ill.

OWENS, WILLIAM EVAN (M. '41), Chf. Engr., State Div. of Conservation, 1107 State Office, Columbus (Res., 779 Oxford St., Worthington), Ohio.

PILCHER, RICHARD LLOYD (Assoc. M. '41), Asst. Engr., Corps of Engrs., War Dept., 1st and M Sts., N.W., Washington, D.C. (Res., 1610 Wilson Blvd., Arlington, Va.)

POST, EZRIEL (Jun. '41), Asst. Supt. of Constr., Silberblatt & Lasker, Inc., 25 West 45th St., New York, N.Y.

PRATT, HAROLD KENNETH (Jun. '41), Asst. Engr., Upper Mississippi Val. Div., U.S. Engr. Dept., New Federal Bldg., St. Louis, Mo.

RAYNER, OLIVER GREENLAW (Assoc. M. '40), Junior Res. Engr., State Highway Dept., Naples, Tex.

REPLOGLE, ALLEN DANIEL (Jun. '41), Junior Engr., Golden Gate National Cemetery, Fort Mason, San Francisco (Res., 510 Boulevard Way, Piedmont), Calif.

RIGGS, EUGENE HOWARD (Assoc. M. '41), Engr., U.S. Engr. Office, Providence, R.I.

RIMMEY, WILLIAM MONROE (Assoc. M. '41), Asst. Engr., U.S. Engr. Office, St. John's, Newfoundland.

ROHDE, CARL (Jun. '41), Asst. Engr., U.S. Engr. Dept., 628 Pittock Block (Res., 2353 South West Cactus Drive), Portland, Ore.

RUGGE, GEORGE (Assoc. M. '41), 1338 Greenleaf Ave., Chicago, Ill.

SALVADORI, MARIO GEORGE (Assoc. M. '41), Instr., Civ. Eng., Columbia Univ., 117th St. and Broadway (Res., 777 West End Ave.), New York, N.Y.

SCARPULLA, NORMAN CHARLES (Jun. '41), Louper, Bethlehem Steel Co., Quincy (Res., 71 Commercial St., East Braintree), Mass.

SCULLEN, ANTHONY JAMES, JR. (Jun. '41), With 121st Engrs., U.S. Army, Fort Belvoir, Va. (Res., 1224 Lawrence St., N.E., Washington, D.C.)

SMITH, BRICE REYNOLDS (M. '41), Office Engr., Sverdrup & Parcel, 1848 Railway Exchange Bldg., St. Louis (Res., 274 Edwin Ave., Glendale), Mo.

SMITH, JOHN PALMER, JR. (Assoc. M. '40), Asst. Engr., Eng. Div., Panama Canal, Balboa Heights, Canal Zone.

SMITH, NATHAN LEWIS (M. '41), Cons. Engr., 1201 St. Paul St., Baltimore, Md.

SNEARY, LOY B. (M. '40), Constr. Engr., MacDonald-Tarlton-Patti Constr. Co., Box 124 (Res., 424 North Van Brunt Blvd.), Kansas City, Mo.

SPENCER, WILLIAM BENJAMIN (M. '41), Chf. Estimator, Consolidated Eng. Co., Inc., 20 East Franklin St., Baltimore, Md.

STEINMETZ, GEORGE PHILIP (M. '41), Chf. Engr., Public Service Comm., 1 West Wilson, Madison, Wis.

STEWART, WILLIAM KENNETH (Jun. '41), Eng. Aid, U.S. Engrs., Wright Bldg. (Res., 702 North Quaker St.), Tulsa, Okla.

STRANGE-BOSTON, ARCHIBALD DONALD (Assoc. M. '41), Engr., Draftsman, Pipe Line Dept., Standard Oil Co. (Res., 824 Oneonta St.), Shreveport, La.

TAYLOR, ELLIS WING (M. '41), (Edward Cray Taylor & Ellis Wing Taylor), 803 West 3d St., Los Angeles, Calif.

TITUS, HORACE OWEN (Assoc. M. '41), Asst. Structural Engr., Bureau of Yards & Docks, U.S. Navy, Navy Yard, Mare Island, Calif.

TRABAND, HAROLD FREDERICK (Assoc. M. '40), Chf. Engr., Office of the Comptroller, City of New York, 631 Municipal Bldg., New York, N.Y.

TRACY, JOHN WILLIAM MERLE (Assoc. M. '41), Lt., CEC, V(s), U.S.N.R., Westfield, Ind.

USTEL, SABIH AZIZ (Jun. '41), 915 Sixth St., S.E., Minneapolis, Minn.

WACHRAMEEFF, ARTEMY (M. '41), Designer, Stone & Webster Eng. Corp., 41 Federal St. (Res., 157 Beacon St.), Boston, Mass.

WEST, CARLETON TAYLOR (Assoc. M. '41), Vice-Pres., Monolith Portland Cement Co., 215 West 7th St., Los Angeles, Calif.

WILSON, EDWIN OLIVER (Jun. '41), Asst. Irrig. Engr., SCS, Box 111, Fillmore, Utah.

WIMER, WALTER LLOYD (Assoc. M. '41), Engr., Wimer Constr. Co., Negley Ave., Butler, Pa.

ZEDER, FRED MORRELL (M. '41), Vice-Chairman of the Board, Chrysler Corp., 341 Massachusetts Ave., Detroit, Mich.

ZEEVAERT WIECHERS, LEONARD (Jun. '41), Civ. Engr., Ingenieria Experimental, C.N.I., San Jacinto (Res., Isabel la Catalica 67, Mexico City), Mexico.

MEMBERSHIP TRANSFERS

BENAS, BENJAMIN (Assoc. M. '35; M. '41), Supt., Richmond-Sunset Sewage Treatment Plant, City and County of San Francisco, 4545 Lincoln Way, San Francisco, Calif.

BLAIN, WILBER ALEXANDER (Jun. '32; Assoc. M. '41), Junior Engr., U.S. Engr. Dept., Post Office Bldg. (Res., 3819 Ave. N$^1/_2$), Galveston, Tex.

BOONE, WESLEY WILLIAMS (Assoc. M. '21; M. '41), Pres., Boone & Webster, Inc., 401 McCall Bldg., Memphis, Tenn.

BRADLEY, CHARLES SMITH (Jun. '34; Assoc. M. '41), Job Engr., Morrison-Knudsen Co., Inc., 319 Broadway, Boise, Idaho. (Res., 260 South 5th St., Brawley, Calif.)

BROWN, JAMES WESLEY (Assoc. M. '38; M. '41), City Engr. (Res., 301 Virginia Ave.), McComb, Miss.

COX, JOHN JOSEPH (Jun. '31; Assoc. M. '41), Junior Engr., Board of Water Supply, 346 Broadway, New York (Res., 31–20 Sixty-ninth St., Jackson Heights), N.Y.

CUDWORTH, ARTHUR GEORGE (Jun. '38; Assoc. M. '40), Structural Engr., Colorado Builders Supply Co., 1534 Blake (Res., 1590 Elm St.), Denver, Colo.

DIDDEN, CLEMENT ALBERT (Jun. '31; Assoc. M. '40), (C. A. Didden Co., Inc.), 614 Colorado Bldg. (Res., 139 Twelfth St., S.E.), Washington, D.C.

ERNEST, RALPH NELSON (Jun. '37; Assoc. M. '41), Lt., CEC, U.S. Navy, Public Works Officer, Submarine Base, Coco Solo, Canal Zone.

FREGOSI, ALBERT (Jun. '30; Assoc. M. '41), Capt., Corps of Engrs., War Dept., U.S. Army, Office Const. Quartermaster, Fort Leonard Wood, Mo.

GOTTLIEB, LEON (Assoc. M. '30; M. '41), Chf. Bituminous Engr., State Highway Dept., Montgomery, Ala.

GRADY, JAMES ARTHUR (Jun. '34; Assoc. M. '41), Const. Supt., E. I. du Pont de Nemours & Co., Morgantown, W.Va.

GRIFFITH, JOSEPH GORDON (Jun. '32; Assoc. M. '41), Asst. Engr., U.S. Engrs., Corozal, Canal Zone.

HARKNESS, FRANK BRACE (Assoc. M. '35; M. '41), Senior Engr. (Civ.), U.S. Div. Engr. Office, 1415 Central National Bank Bldg. (Res., 1406 Greycourt Ave.), Richmond, Va.

HICKMAN, HAROLD CLARENCE (Jun. '32; Assoc. M. '40), Asst. Engr., U.S. Engr. Office, War Dept., Federal Bldg. (Res., 12026 Manor Ave.), Detroit Mich.

JERVIS, WILLIAM HORACE (Jun. '34; Assoc. M. '41), Chf., Soils Section, Vicksburg Eng. Dist., U.S. Engr. Office, Box 60, Vicksburg, Miss.

KJELLMAN, VICTOR HARRY (Jun. '37; Assoc. M. '41), Asst. Engr., War Dept., U.S. Engr. Office, Park Sq. Bldg., Boston, Mass.

KRAUSS, WOLFGANG WALTER (Assoc. M. '35; M. '41), Civ. Engr., Truscon Steel Co., Youngstown, Ohio.

LEVEL, ANDREW DUARTE, JR. (Jun. '39; Assoc. M. '41), (Mogensen & Duarte), Edificio Washington, Caracas, Venezuela.

McCAIN, JOHN IRVING, JR. (Jun. '36; Assoc. M. '40), 161 Hollywood Drive, New Orleans, La.

MESSER, RICHARD (Jun. '10; Assoc. M. '12; M. '41), Director, Bureau of San. Eng., State Dept. of Health, 708 State Office Bldg., Richmond, Va.

MOSHER, SIDNEY WOOD (Assoc. M. '26; M. '41), Engr. Examiner in Chg., Municipal Civ. Service Comm., 299 Broadway, New York (Res., 117-27 Two hundred and thirty-first St., St. Albans), N.Y.

NAGLE, JOHN LEO (Assoc. M. '20; M. '41), Head Engr., Eastern Div., Corps of Engrs., U.S. Army, 2 New York Ave., Room 400, Washington, D.C.

NUTE, JOHN WARREN (Jun. '33; Assoc. M. '41), Office Engr., The Permanente Corp., Los Altos (Res., 1344 Hedding St., San Jose), Calif.

O'FARRELL, JOHN JOSEPH (Jun. '28; Assoc. M. '40), Asst. Cost Engr., The C. & O. Ry., 547 East Church St., Marion, Ohio.

OGLESBY, CLARKSON HILL (Jun. '36; Assoc. M. '41), Special Instr., Civ. Eng., Univ. of Arizona, Tucson (Res., 377 North 5th Ave., Phoenix), Ariz.

POPPER, WILLIAM (Jun. '35; Assoc. M. '41), Asst. Bridge Engr., State Div. of Highways, Box 1499 (Res., 5409 U St.), Sacramento, Calif.

RAMSEY, PHILIP BRUCE (Jun. '40; Assoc. M. '41), Structural Engr., Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh, Pa.

RIESBOL, HERBERT SPENCER (Jun. '29; Assoc. M. '41), Hydr. Engr., SCS, U.S. Dept. of Agriculture (Res., 1410 Denman Ave.), Coshocton, Ohio.

SCHOTT, EUGENE ALBERT (Jun. '31; Assoc. M. '41), 1011 North Walnut St., Dover, Ohio.

SENKPIEL, WILLIAM CHRISTIAN GUSTAVE (Jun. '30; Assoc. M. '41), Hydr. Engr. in Chf., Water & Power Div., Conservation Branch, U.S. Geological Survey, 208 New Customhouse, Denver, Colo.

SESSUMS, ROY THOMAS (Jun. '36; Assoc. M. '41), Dean, School of Eng. and Prof., Civ. Eng., Louisiana Polytechnic Inst., Technical Station (Res., 304 West Georgia Ave.), Ruston, La.

SLATER, HAROLD HERBERT (Jun. '31; Assoc. M. '41), Asst. Engr., County Engrs. Office, Court House, Wooster, Ohio.

SMITH, WALTER LANE (Jun. '36; Assoc. M. '41), Pres., Memphis Stone & Gravel Co., 1828 Exchange Bldg., Memphis, Tenn.

STEWART, LOWELL O. (Assoc. M. '29; M. '41), Prof. and Head, Dept. of Civ. Eng., Iowa State College, Ames, Iowa.

WELDEN, RICHARD WAYNE (Jun. '32; Assoc. M. '41), Constr. Engr., Welden Brothers (Res., 1711 West Washington Ave.), Iowa Falls, Iowa.

WINFREY, ROBLEY (Assoc. M. '35; M. '41), Research Associate Prof., Civ. Eng., Eng. Experiment Station Laboratory, Iowa State College, Ames, Iowa.

WOOD, BENSON JARVIS (Jun. '31; Assoc. M. '41), Structural Engr., Smith, Hinchman & Grylls, Inc., 800 Marquette Bldg. (Res., 14753 St. Mary's), Detroit, Mich.

REINSTATEMENTS

BAKER, GEORGE FARNSWORTH, Assoc. M., reinstated June 9, 1941.

GRIFFITH, JAMES RINALDO, M., reinstated May 26, 1941.

HAGEMAN, EARL LIVINGTON, M., reinstated May 12, 1941.

LANGTHORN, JACOB STINMAN, JR., Assoc. M., reinstated May 23, 1941.

MESSNER, EDWARD GRANT, Assoc. M., reinstated June 5, 1941.

RICE, WILLIAM ERNEST, M., reinstated May 12, 1941.

ROSS, CHARLES RAYMOND, Assoc. M., reinstated May 17, 1941.

STREHAN, GEORGE ERNEST, Assoc. M., reinstated June 2, 1941.

RESIGNATIONS

BACKMAN, JOHN EDWARD, Jun., resigned May 15, 1941.

CHAPMAN, STANLEY ALBA, Assoc. M., resigned May 29, 1941.

MILAZZO, GIOVITO JOSEPH, Jun., resigned May 7, 1941.

STAHLE, HAROLD JOHN, Assoc. M., resigned May 27, 1941.

TEBBS, PAUL McGOWAN, M., resigned May 15, 1941.

WINANT, LAWRENCE, Assoc. M., resigned June 4, 1941.

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The amount of money you make out of a job depends mostly on the efficiency and operating cost of the equipment you use. Over-power the job, and you pay in profits. Power it right — and it *pays you* profits!

This means you ought to get to know *all sizes* of "Caterpillar" Diesel Tractors, including the smaller sizes *down to* 25 and 35 drawbar horsepower. These "Caterpillar" Diesels — and the drawn and mounted equipment specially designed to work with them — can dig *good money* out of jobs that you might have thought didn't have money in them! Write for the FREE booklet, "Bigger Profits on the Small Jobs."

CATERPILLAR TRACTOR CO., PEORIA, ILL.

↑ A small, handy, economical excavator, if you want to use it for that—or you can turn it loose on any one of a variety of light jobs. It's a "Caterpillar" Diesel D4 Tractor equipped with a Traxcavator. Uses only about 2 gallons of low-cost fuel an hour!

↑ A "Caterpillar" Diesel Tractor, with a Hyster winch (such as this D2), has a wide spread of usefulness; gives you many opportunities for profit on odd jobs. This one, pulling stumps from a golf course near Lakeland, Florida, uses about 10c worth of fuel an hour!

A money-making outfit on a variety of small jobs! "Caterpillar" Diesel D4 Tractor with LaPlant-Choate 'dozer and 4-yard rear-dump scraper. T. Spaulding Haynes, Baltimore, Md., has it grading and leveling building lots. Uses $1.08 worth of fuel in a 9-hour day! ↓

↑ "Best piece of equipment made for piece-work and light contracting requirements," says D. E. Patterson, Burlington, N. C.—owner of this "Caterpillar" Diesel D2 Tractor and LaPlant-Choate roadbuilder shown grading a fill. Uses 1½ gallons of 7c fuel an hour.

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ENGINES AND ELECTRIC SETS • TRACK-TYPE TRACTORS • ROAD MACHINERY

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

July 1, 1941 NUMBER 7

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

BURCHARD, JOHN ELY, Winchester, Mass. (Age 42) (Claims RC 12.5 D 7.5) 1926 to 1930 (part of time) Instructor, and 1938 to date Prof., Massachusetts Inst. of Technology; previously with Housing Co., Boston, Mass.

CONKEY, CHARLES ROLLAND, Minneapolis, Minn. (Age 54) (Claims RCA 4.0 RCM 23.0) 1916 to date with Fegles Constr. Co., Ltd., as Chf. Draftsman, Chf. Engr., and past 19 years Vice-Pres. and Gen. Mgr.

CURTIS, DONALD DEXTER (Assoc. M.), Clemson, S.C. (Age 45) (Claims RCA 3.7 RCM 11.7) Sept. 1929 to date Prof. of Mechanics and Hydraulics, in charge of teaching and research, School of Eng., Clemson Coll.

DUGGAN, HOWARD WILLIAM, Watertown, N.Y. (Age 35) (Claims RCA 2.7 RCM 5.7) Sept. 1933 to July 1934 Draftsman, and Aug. 1934 to date Engr., Stebbins Eng. & Mfg. Co.

FOOTE, FRANCIS SEELEY (Assoc. M.), Berkeley, Calif. (Age 58) (Claims RCA 1.5 RCM 28.8) July 1912 to June 1917 Asst. Prof., and July 1917 to date Prof., of R.R. Eng. and Director of summer surveying camp, Univ. of California.

HEINDEL, JUDSON CLIFFORD, Signal Mountain, Tenn. (Age 46) (Claims RC 5.6 D 2.1) Sept. 1937 to date with TVA, as Prin. Eng. Draftsman, and (since Jan. 1941) Asst. Structural Engr.; previously with N.Y. Power & Light Corporation, Albany, N.Y., as Special Steel Draftsman, and Draftsman.

JOHNSON, DONALD CHARLES, Berkeley, Calif. (Age 37) (Claims RC 9.4 D 6.7) Sept. 1935 to date Asst. Regional Engr., Pacific Southwest Region, SCS, U.S. Dept. of Agriculture.

JUDD, FRANK RHYMAL (Assoc. M.), Chicago, Ill. (Age 59) (Claims RCM 37.2) April 1904 to date with Illinois Central R.R., as Designing Draftsman, Chf. Draftsman, Asst. Engr., and (since Nov. 1915) Engr. of Bldgs.

KIKER, JOHN EWING, JR. (Assoc. M.), Poughkeepsie, N.Y. (Age 35) (Claims RCA 3.0 RCM 7.8) Oct. 1936 to date Dist. San. Engr., New York State Dept. of Health; previously San. Engr. with John R. Stubbins, Cons. Engr., Caracas, Venezuela; Chemical and San. Engr. with S. T. Powell, Cons. Engr., Baltimore, Md

KLOTZ, RUSSELL LOUIS (Assoc. M.), Balboa Heights, C.Z. (Age 46) (Claims RCA 11.8 RCM 10.9) Sept. 1929 to date with The Panama Canal, as Asst. Engr., Associate Engr., Engr., Asst. to Chf. and Acting Chf. of Plans Sec., and (since Feb. 1939) Associate Engr. and (at present) Engr., Special Eng. Div.

LOCKWOOD, MASON GRAVES, Houston, Tex. (Age 38) (Claims RCA 1.0 RCM 9.5) 1935 to date member of firm, Lockwood & Andrews, Cons. Engrs.

MALE, MILTON (Assoc. M.), Pittsburgh, Pa. (Age 36) (Claims RCA 4.9 RCM 6.0) June-Sept. 1930 and Sept. 1931 to date with United States Steel Corporation as Asst. Research Engr., and (since June 1939) Research Engr.

MEEK, THOMAS HARRIS, Charleston, W.Va. (Age 40) (Claims RC 16.0 D 8.7) July 1936 to date with Constr. Eng. Dept., Carbide & Carbon Chemical Corporation, as Structural Engr., and (since April 1940) Job Engr.

MILLER, SHANNON ERNEST, Dallas, Tex. (Age 40) (Claims RC 9.3 D 7.8) Oct. 1923 to date with Austin Bridge Co., as Timekeeper, Field Supt., and (since Dec. 1928) Constr. Engr.

NETTLETON, ELWOOD THOMAS (Assoc. M.), Hamden, Conn. (Age 42) (Claims RCA 8.7 RCM 9.0) March 1940 to date Gen. Mgr., and since Jan. 1941 also Vice-Pres., The Suzio Trap Rock Co., L. Suzio Constr. Co., York Hill Quarry Co., and L. Suzio Trap Rock Co., Meriden, Conn.; previously Secy. and Eng Director, New York State Crushed Stone Association, Inc.; with Connecticut Quarries Co., Inc., and New Haven Trap Rock Co., New Haven, Conn.

OSCHRIN, LEO, New York City. (Age 41) (Claims RCA 5.2 RCM 9.0) Dec. 1940 to date Engr., Fraser & Brace Eng. Co.; Dec. 1939 to Dec. 1940 Chf. Engr. and member of firm, Foote Constr. Co.; previously with PWA, as Res. Engr. Inspector, Traveling Engr., and Senior Engr.

PAPE, RAYMOND FRED, Ancon, Canal Zone. (Age 35) (Claims RCA 3.5 RCM 6.5) 1935 to date with Dept. Engr., U.S. Army, as Constr. Foreman, Jun. Engr., Asst. Engr., and Associate Engr.

PERKINS, MAC DUDLEY, San Francisco, Calif. (Age 44) (Claims RCA 3.0 RCM 11.7) March 1937 to date Cons. Structural Engr.; previously Structural Engr., Golden Gate International Exposition.

PRATT, AVERY JUDSON, Buffalo, N.Y. (Age 54) (Claims RCA 3.0 RCM 25.0) March 1920 to date with R. S. McMannus Steel Constr. Co., Inc., as Chf. Engr. and Gen. Manager, and (later) Vice-Pres.

RASCH, HARRY BLANDFORD, Chicago, Ill. (Age 35) (Claims RCA 3.6 RCM 10.8) Jan. 1928 to date with International Filter Co., as Asst. Estimator, Field Engr., Chf. Estimator, Sales Engr., and (since Jan. 1933) Water Treatment Engr.

REILLY, RAYMOND THOMAS, Camp Polk, La. (Age 51) (Claims RCA 14.7 RCM 8.5) Oct. 1940 to date with Benham Eng. Co., Archt.-Engr. for U.S. Army, as Engr. and Acting Archt. Engr., and (since March 1941) Chf. Engr.; previously with Alvord, Burdick & Howson, Cons. Engrs., Chicago, Ill., as Asst. Engr. and Associate Engr.

STEVENS, RAYMOND LATIMER, Washington, D.C. (Age 35) (Claims RCA 7.5 RCM 6.5) Oct. 1935 to date with U.S. Dept. of Agriculture, SCS, as Asst. Project Engr., Asst. Regional Engr., Engr., and (since May 1940) Senior Hydr. Engr.

STEVENSON, ALBERT LESTER (Assoc. M.), Port Washington, N.Y. (Age 51) (Claims RCA 8.3 RCM 17.0) July 1913 to March 1918 Asst. to Elwyn E. Seelye, Cons. Engr., and Jan. 1919 to date member of firm, Elwyn E. Seelye & Co., New York City.

STRANGE, ORMAN MORTON (Assoc. M.), Cashiers, N.C. (Age 40) (Claims RCM 7.1) July 1940 to date Job Engr., Morrison-Knudsen Co., Inc., Boise, Idaho; previously Engr. for William Tamminga, Gen. Contr., and Broderick & Gordon, Gen. Contrs., both of Denver; with Denver Board of Water Commrs., on Moffat Water Tunnel project, as Asst. Engr., Gen. Foreman, Supt., and Field Engr.

STREHAN, GEORGE ERNEST (Assoc. M.), New York City. (Age 55) (Claims RCA 4.2 RCM 25.7) July 1919 to date Cons. Engr. on building construction.

VANDENBURGH, EDWARD CLINTON, JR., Chicago, Ill. (Age 54) (Claims RCA 3.7 RCM 27.2) July 1908 to date with Chicago North Western Ry., as Tapeman, Rodman, Draftsman, Instrumentman, Signal Inspector, Chf. Draftsman, Asst. Engr., Asst. Gen. Bridge Inspector, Supervisor, Div. Engr., and (since April 1940) Engr. of Maintenance on system.

WELLS, CODIE DEAN, Austin, Tex. (Age 40) (Claims RCA 6.7 RCM 9.1) Feb. 1928 to date with Texas Highway Dept., as Asst. Res. Engr., Asst. Constr. Engr., State Constr. Engr., and (since Aug. 1940) Engr. of Special Assignments.

APPLYING FOR ASSOCIATE MEMBER

AALTO, JOHAN AUGUST (Junior), New York City. (Age 33) (Claims RCA 7.7 RCM 2.4) Feb. 1939 to date Asst. Engr., Office of Comptroller; previously Topographical Draftsman for Pres., Borough of Queens; Eng. Asst. and Topographical Draftsman for Pres., Borough of Bronx.

AKANS, JAMES ERNEST (Junior) Cincinnati, Ohio. (Age 32) (Claims RCA 3.0) Feb. 1941 to date Jun. Engr., M. of W., Southern Ry. Co.; previously with TVA as Senior Eng. Aide, and Prin. Engr. Aide.

BARROWS, DANIEL JOSEPH (Junior), Jackson Heights, N.Y. (Age 32) (Claims RCA 5.2 RCM 2.4) Dec. 1933 to Dec. 1936 Field Engr., July 1937 to Feb. 1940 Cost. Engr., and Feb. 1940 to date Eng. Asst., Spencer, White & Prentis, Inc., Engrs. and Contrs., New York City; in the interim Field Engr., Eng. Constr. Corporation, Alton, Ill.

BRENNAN, WILLIAM RAYMOND, Beaumont, Tex. (Age 40) (Claims RCA 8.3 RCM 5.1) April 1930 to date with American Petroleum Co., as Instrumentman, Locating Engr., Res. Engr., and (since May 1936) Constr. Engr.

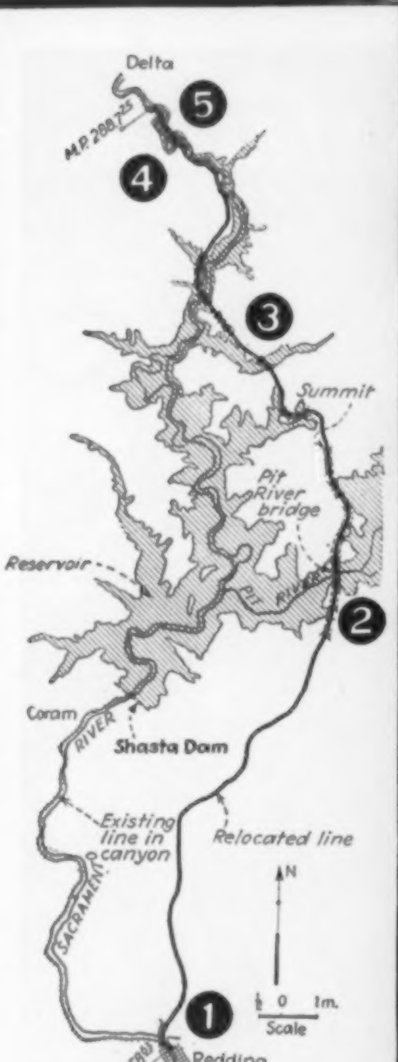
BROWN, THANE EDWIN, La Porte, Ind. (Age 31) (Claims RCA 4.0) Jan. 1941 to date Chf. of Party, Chas. Cole & Son, Kingsbury Ordnance Plant; previously Asst. Technician (Cr. Engr.), Wisconsin Conservation Dept., CCC Div.

CAMPBELL, WALLACE ROSS, Kansas City, Mo. (Age 41) (Claims RC 5.0) May 1925 to date with Black & Veatch, Cons. Engrs.

CARLSON, ELNER WILFRED, Cincinnati, Ohio. (Age 36) (Claims RCA 3.6 RCM 0.5) Jan. 1940 to date Hydrologic Supervisor, U.S. Weather Bureau; previously Inspector, Jun. Engr. and Asst. Engr., U.S. Engr. Office.

CARR, JOE MATT, El Paso, Tex. (Age 30) (Claims RCA 4.8 RCM 3.7) Sept. 1936 to date with state and local health departments as San. Engr. in charge of Bureau of Sanitation in City-County Health Unit at El Paso, Tex.; previously with U.S. Public Health Service.

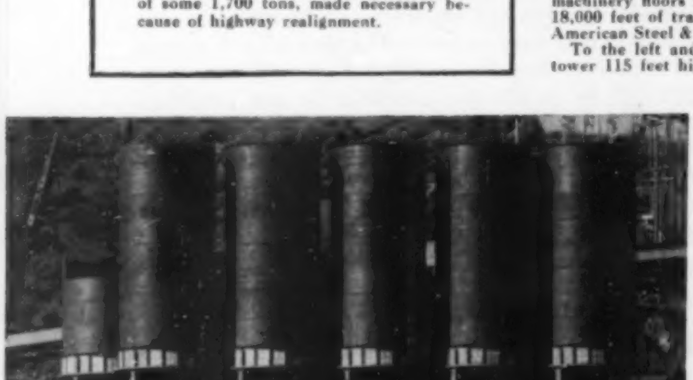
COOMBE, JOHN VAN VEGHTEN (Junior), Washington, D.C. (Age 32) (Claims RCA 5.3



Showing relocated Southern Pacific main line. Necessary to this 30-mile relocation was the building of 8 railroad bridges. American Bridge Company contracted with the Bureau of Reclamation for the following five — requiring some 25,000 tons of steel: (1) First crossing of the Sacramento. (2) Pit River. (3) Salt Creek. (4) Third Crossing. (5) Fourth Crossing. In addition to these, American Bridge Company, under contract with Columbia Steel Company, also constructed the Antler Bridge, a highway structure of some 1,700 tons, made necessary because of highway realignment.

4000-ton Head-Tower. Designed, fabricated and erected by American Bridge Company, this head-tower, whose height above anchorage is equivalent to a 50-story bldg., carries within its upper 200 feet, 6 utility and machinery floors and is capped by a 21-foot-square floor at which the radiating cableways are anchored. Some 18,000 feet of tramway cable and 77,000 feet of operating rope for the cableway system were manufactured by American Steel & Wire Company. An additional 53,000 feet of operating rope was supplied by Columbia Steel Co.

To the left and dwarfed by the magnitude of the head-tower, is seen the concrete mixing plant, a circular tower 115 feet high containing steel bins. This was also fabricated by American Bridge Company.



←**Cement Blending Plant.** Construction view. This plant comprises 10 aggregate storage bins, each 23 feet in diam. and 73¼ feet high, and about 1,000 feet of steel trestle, all under contract to Columbia Steel Company. Bin supports and trestle were fabricated by American Bridge Company.

Movable Tail Towers. Construction view. Under contract to Columbia Steel Company were the 3 movable tail towers, 125 feet high, to which individual cableways some 2,670 feet long are anchored. Cableways carry concrete skips for placement of more than half of the total concrete entering into the dam. Four steel trestles on which some of the tail towers operate were fabricated by American Bridge Company.→

Mighty Shasta Dam

AND THE PART PLAYED IN IT BY U·S·S STRUCTURAL STEEL

THIS titanic unit of the Central Valley Project for the control of floods, the conservation of water and the creation of electric power, will impound the flow of the Sacramento River some 12 miles above Redding, California. Engineers will note many outstanding features, some of which are unsurpassed in construction history.

For instance: the more than 10 miles of conveyor belt system for transporting aggregate. More concrete than Boulder Dam, though not as high. Highest overflow gravity dam yet built. Relocation of 30 miles of Southern Pacific R.R., and its Pit River Bridge with the highest piers ever built (358 feet). A construction plant designed to produce and place the 6,000,000 cu. yds. of concrete entering into the Dam.

Key unit of the construction plant, and perhaps the largest and heaviest piece of construction equipment ever built, is the steel head-tower which anchors the seven radial cableways for the placement of concrete. This rises 460 feet above ground surface and penetrates varying depths into bedrock for anchorage. The maximum height from anchorage to top is 562 feet. The cableways, suspended across the river canyon to carry 8-cubic-yard buckets, terminate at individual movable tail-towers which swing in arcs up to 42 degrees.

Participation of American Bridge Company and other subsidiaries of United States Steel in the requirement of this outstanding project was extensive. Mill products of Columbia Steel, American Steel & Wire Company and Carnegie-Illinois Steel Corporation entered into the various units of the construction plant, practically all of which were under contract to Columbia Steel Company.

American Bridge, as sub-contractor to Columbia Steel, supplied some 5,800 tons of fabricated steel, and an additional 1,700 tons for a bridge structure made necessary by highway realignment.

American Bridge, under contract to the Bureau of Reclamation, has under construction, or completely fabricated and erected, an additional 25,000 tons of bridges for the relocation of the Southern Pacific main line.

Here is a splendid illustration of how the facilities and products of United States Steel Subsidiaries combine with American Bridge to meet any project need.

1st crossing of the Sacramento River. This is near Redding and consists of a single track deck viaduct on curve and grade, sweeping across the river bottoms from the heights on either side. 4,271 feet long, it is typical of the other bridge crossings of the Sacramento.

AMERICAN BRIDGE COMPANY

General Offices: **Frick Building, Pittsburgh, Pa.**

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Duluth · Minneapolis · New York · Philadelphia · St. Louis

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL

RCM 0.6) Dec. 1940 to date in charge of fatigue testing at David Taylor Model Basin, Navy Dept.; previously Special Research Asst. in Civ. Eng., Univ. of Illinois; 1st Lieut. on active duty with CCC.

CROOKS, JAMES GRAHAM (Junior), Washington, D.C. (Age 32) (Claims RCA 4.9) June 1941 to date Lieut. (jg) C.E.C., U.S. Navy; previously with Bethlehem Steel Co., as Jun. Designer, and Contr. Engr.

CURTIS, IRA NANKERVIS (Junior), Saginaw, Mich. (Age 32) (Claims RCA 3.1) May 1939 to date Lieut. (jg), C.E.C., U.S. Navy, at present on temporary duty in Bureau of Yards and Docks, Washington, D.C.; previously Inspector, Student Engr., and Jun. Engr., U.S. Engr, Office, Milwaukee, Wis.

ERICHSEN, FRANK PETER (Junior), Milwaukee, Wis. (Age 32) (Claims RCA 6.2 RCM 1.9) Jan. 1935 to date with SCS, U.S. Dept. of Agriculture as Associate Agri. Engr., and (since Aug. 1939) Associate Hydr. Engr.

FARMER, SIDNEY FRENCH (Junior), Louisville, Ky. (Age 32) (Claims RCA 6.5) May 1939 to May 1940 Jun. Engr., and May 1940 to date Asst. Engr., U.S. Engr. Office; previously Jun. Engr., U.S. Bureau of Reclamation, Denver, Colo.

FARQUHAR, ROBERT EDWARD, College Station, Tex. (Age 37) (Claims RCA 8.5 RCM 4.9) Feb. 1941 to date Engr., American Rolling Mill Co., Houston, Tex.; previously Asst. Engr., U.S. Dept. of Agriculture and U.S. Forest Service.

FINLAYSON, ROBERT ARCHIBALD, Bremerton, Wash. (Age 39) (Claims RCA 7.3 RCM 3.8) May 1940 to date Asst. Naval Archt., Puget Sound Navy Yard; July 1936 to May 1940 City Manager, Montrose, Colo.; previously Draftsman, Colorado State Highway Dept.

FOX, JEFF STANLEY (Junior), Longview, Tex. (Age 30) (Claims RCA 5.7) March 1941 to date member of firm of Thackwell & Fox.; previously Prin. Asst. Engr. to H. L. Thackwell, Cons. Engr., Longview, Tex.; with Texas State Highway Dept., as Instrumentman and Field Engr.

GAMBRELL, JAMES WYATT (Junior), Asheville, N.C. (Age 27) (Claims RCA 3.2) Oct. 1936 to March 1940 Jun. Hydr. Engr., and March 1940 to date Asst. Hydr. Engr., U.S. Geological Survey; previously Under Eng. Aide, SCS, Anderson, S.C.

GARRETT, JOHN A. Decatur, Ala. (Age 32) (Claims RCA 4.6 RCM 0.8) April 1938 to date with WPA as Project Supervisor of Recreational Area Study, Safety Engr., and (since Dec. 1940) Gen. Area Supt.; previously with State Comm. of Forestry, and National Park Service.

GENTILICH, JOHN STONE (Junior), New Orleans, La. (Age 32) (Claims RCA 6.6) Aug. 1938 to date with U.S. Engr. Office as Jun. and Asst. Engr. Chf., Eng. Div., and (since March 1941) Asst. Engr. Chf., Deep Water Navigation Div.; previously with U.S. Waterways Experiment Station as Asst. Model (hydraulic) Operator, Inspector and Jun. Engr.

GIDLEY, HARRY KENNETH (Junior), Charleston, W.Va. (Age 32) (Claims RCA 5.4) Jan. 1936 to date with State Health Dept., as Superv. Engr., and (since Dec. 1938) Associate Engr., Div. of San. Eng.

GOLDBLOOM, JOSEPH (Junior), Bayside, N.Y. (Age 32) (Claims RCA 2.6) June 1941 to date Asst. Civ. Engr., Air Corps, U.S. War Dept.; previously with Madigan-Hyland as Inspector, Acting Chf. of Party, Res. Inspector, and Gen. Inspector.

GREENWOOD, GEORGE HAMILTON, Cavite, P.I (Age 33) (Claims RCA 2.6) May 1941 to date Lieut. (jg), CEC, U.S.N.R., Headquarters 16th Naval Dist.; May 1929 to May 1941 with California Div. of Highways, Dist. 10, as Highway Draftsman (Grade II), Timekeeper, Jun. Highway Engr., and Asst. Highway Engr., etc.

HAHN, ROBERT LE ROY (Junior), Kansas City, Mo. (Age 31) (Claims RCA 4.2) April 1937 to date Structural Engr., Jones-Hettelsater Constr. Co.; previously with Kansas State Highway Comm.

HALLOCK, HARRY EARNEST (Junior), Fort Bragg, N.C. (Age 33) (Claims RCA 8.4) Nov. 1940 to date Capt., Field Artillery, U.S. Army; previously with Ohio State Highway Dept., Bureau of Tests, as Inspector, and Asst. Engr.

HANKINS, LAWRENCE DONALD (Junior), Coeur d'Alene, Idaho. (Age 32) (Claims RCA 2.1) 1934 to 1939 (at intervals) and Sept. 1940 to date with U.S. Geological Survey, at present as Senior Eng. Field Aide; in the interim with Cunningham and Associates, Cons. Engrs.

HUBBARD, LEONARD SARGENT, San Francisco, Calif. (Age 45) (Claims RCA 11.0 RCM 1.1) Feb. 1933 to date with U.S. Coast & Geodetic Survey as Chf. of Party, Jun. Officer, Navigating Officer, and Executive Officer.

HUTCHINSON, HOMER BRINSON, JR. (Junior), Monsanto, Ill. (Age 32) (Claims RCA 1.7) April 1941 to date with Office of Constr. Quartermaster, War Dept., Chemical Warfare Service, St. Louis Plant, Monsanto, Ill., as Asst. to Constr. Quartermaster; previously with TVA, Knoxville, Tenn., as Engr. Surveys Rodman, Rodman, Head Chainman, Leverman, and Inspector.

IZATT, JOHN ORMOND (Junior), Stanfield, Ore. (Age 32) (Claims RCA 4.9 RCM 0.3) Jan. 1941 to date Chf. Materials Inspector, Stevens and Koon, Archt.-Engrs. for Umatilla Ordnance Depot at Hermiston, Ore.; previously Asst. Materials Engr., Idaho Dept. of Public Works, Boise; with Idaho Bureau of Highways at Pocatello, as Inspector, Instrumentman, Computer, etc.

KENNEDY, JOSEPH MICHAEL (Junior), New York City. (Age 27) (Claims RCA 2.9) Nov. 1936 to date with U.S. Engr. Office as Eng. Draftsman (Topographical), Jun. Engr. (Civil), and (since April 1941) Asst. Engr. (Civil).

KUMAR, RANJIT, Trinidad, B.W.I. (Age 29) (Claims RCA 4.3 RCM 2.0) Dec. 1940 to date Asst. Estimating Engr., Walsh Driscoll Constr. Co., Contrs. for U.S. Army base, Port of Spain, Trinidad; previously Asst. Engr., Public Works Dept., Trinidad; Designer and Draftsman, Trinidad Leaseholds, Ltd., Pointe a Pierre; in private commercial work in Trinidad.

LANGSNER, GEORGE (Junior), Alhambra, Calif. (Age 33) (Claims RCA 4.0) Oct. 1936 to date with California Div. of Highways as Jun. Highway Engr., and (since March 1941) Asst. Highway Engr.

MARTIN, EARL HOWARD (Junior), Fort Benning, Ga. (Age 32) (Claims RCA 4.0) July 1940 to date 1st Lieut., 71st Engr. Co. (Light Ponton); July 1937 to July 1940 San. Engr., State Health Dept.; previously Chemist, U.S. Public Health Service.

PACKARD, DANIEL BERRY, JR. (Junior), Wilmington, N.C. (Age 33) (Claims RCA 4.4) Feb. 1937 to date with Atlantic Coast Line R.R. Co. as Asst. Supervisor of Bldg. Repairs, Asst. Engr., and (since March 1941) Senior Asst. Engr.; previously with North Carolina State Highway & Public Works Comm.

PAVLO, ALEXANDER LEO, Brooklyn, N.Y. (Age 31) (Claims RCA 0.3 RCM 3.9) Dec. 1935 to date Structural Designer with Madigan-Hyland, Cons. Engrs., Long Island City.

PRATER, HERBERT E (Junior), Mobile, Ala. (Age 33) (Claims RCA 2.7 RCM 2.2) Nov. 1940 to date 1st Lieut., U.S. Army; previously Jun. Engr., Asst. Engr. and Associate Engr., Dams Design Sec., U.S. Bureau of Reclamation, Denver, Colo.

PRENDERGAST, JASPER MATTHEW, Balboa Heights, C.Z. (Age 53) (Claims RCA 20.3) May 1920 to date with The Panama Canal, as Topographic Draftsman, Dist. Engr., and (since July 1933) Dept. Engr. Corozal, C.Z.

PRYOR, WILLIAM THURMAN, Ogden, Utah. (Age 35) (Claims RCA 7.5) June 1930 to date with U.S. Bureau of Public Roads (PRA), as Jun. Highway Engr., Asst. Res. Engr., Res. Engr., Locator and Chf. of Party, Chf. Locator, Asst. Highway Engr., etc., and (since Jan. 1941) in Dist. Office writing survey report and in charge of design, Enterprise-St. George and Strawberry-Sharon surveys.

RICHARDSON, DONALD WHITNEY, Scranton, Pa. (Age 33) (Claims RCA 2.0) Jan. 1940 to date Asst. Engr., Municipal Eng. Div., The Panama Canal; previously Jun. Engr., PWA, Harrisburg, Pa.; Gen. Foreman, R. D. Richardson Constr. Co., Scranton, Pa.; Asst. Plant Engr., Imperial Paper & Color Co., Glens Falls, N.Y.; Draftsman, Union Bag & Paper Corporation, Hudson Falls, N.Y.

ROGERS, JOHN WILLARD (Junior), La Porte, Ind. (Age 32) (Claims RCA 6.7) Aug. 1935 to date with Bates & Rogers Constr. Corporation, as Mech. Engr., Supt. of Constr., Supt. of bridge construction, Asst. Supt. of tunnel operations, etc., and (since Nov. 1940) Asst. Gen. Supt.

ROUSE, HAROLD DOUGLAS, Stewart Manor, N.Y. (Age 35) (Claims RCA 4.0 RCM 2.7) May 1932 to date Transitman (Grade 4), Dept. of Sanitation, Bureau of Sewage Disposal and Intercepting Sewers, New York City.

RUTT, FRANK EDWARD (Junior), Louisville, Ky. (Age 32) (Claims RCA 7.2) July 1931 to date with U. S. Engr. Office as Student Engr., Jun. Engr. and (since May 1939) Asst. Engr.

SHANNAHAN, GEORGE DAVID (Junior), Los Angeles, Calif. (Age 33) (Claims RCA 3.2 RCM 5.6) June 1932 to date with Shannahan Bros., Inc., Railroad and Gen. Contrs., Huntington Park, Calif., being Gen. Contr.

SMITH, WILBUR STEVENSON (Junior), Columbia, S.C. (Age 29) (Claims RCA 4.2) June 1933 to July 1935, Sept. 1935 to Sept. 1936, June 1937 to May 1940 and May 1941 to date with South Carolina State Highway Dept., as Field Engr., Laboratory Asst., Asst. Director of South Carolina Traffic Safety Survey, Traffic Engr. Asst., and at present traffic Engr.; May 1940 to May 1941 Asst. Prof., Bureau for Street Traffic Research, Yale Univ.

WILKIE CHARLES BALDWIN, Norwood, Ohio (Age 40) (Claims RCA 2.2 RCM 5.9) Feb. 1937 to date Structural Designer and Project Engr., The H. K. Ferguson Co., Cleveland, Ohio; previously Chf. Draftsman, Union Structural, Inc., and C. F. Stanton Eng. Co., Syracuse, N.Y.; Squad Leader, The Petroleum Iron Works Co., Beaumont, Tex.

WILSON, THOMAS EVANS, JR. (Junior), Ridgeland, S.C. (Age 31) (Claims RCA 4.4 RCM 1.4) June 1931 to April 1932 and June 1936 to date with South Carolina Highway Dept., as Inspector, Instrumentman, Asst. Res. Engr., and (since Feb. 1940) Res. Engr.

WILSON, WALTER THIELL, Rockville, Md. (Age 32) (Claims RC 4.5) Nov. 1939 to date Asst. Hydrologic Engr., U.S. Weather Bureau; previously Jun. Agri. Engr., SCS.

WOODRUFF, SETH RITCH, JR., Diablo Heights, C.Z. (Age 33) (Claims RCA 3.3 RCM 5.5) March 1940 to date Engr. and Senior Engr., Special Eng. Div., Dept. of Operation and Maintenance, The Panama Canal, Balboa Heights, C.Z.; previously with U.S. Engr. Office as Jun. Engr., Asst. Engr., Associate Engr., and Engr.

YOUNG, JOHN FREDERICK, Rhinelander, Wis. (Age 41) (Claims RCA 7.6 RCM 7.7) Aug. 1940 to date with Rhinelander (Wis.) Paper Co. as Structural Engr. on paper-mill design; previously Structural Engr., Kimberly-Clark Corporation, Neenah, Wis.; in private practice; Designing and Superv. Engr. on design of drying equipment, heating, ventilating and air-conditioning; Engr., Illinois Highway Div.

ZIMMERMAN, ABE, Indianapolis, Ind. (Age 31) (Claims RCA 5.5) Jan. 1941 to date Field Engr., NYA; April 1937 to Jan. 1941 Jun. Engr., ECW; previously with Indiana State Highway Comm.

ZUKOWSKI, HENRY MIECZYSLAW, Chicago, Ill. (Age 36) (Claims RCA 11.0) June 1926 to date with Greeley & Hansen, Hydr. and San. Engrs. as Draftsman, Tracer, Designer, Estimator, and (since Jan. 1929) Structural Designer.

APPLYING FOR JUNIOR

AVERY, EDWARD FREDERICK, Morro Bay, Calif. (Age 31) (Claims RCA 2.2 RCM 1.5) Dec. 1940 to date Coordinating Engr., L. E. Dixon Co., Contrs., Camp San Louis Obispo, Calif.; previously Surveyman, U.S. Engr. Office Flood Control; Superv. Engr., Ravenwood Development, Falls Church, Va.; Asst. Chf. of Claims Audit Unit, FHA, Washington, D.C.

BALDINGER, EDWARD JOSEPH, Walkerton, Ind. (Age 25) 1940 B.S. in C.E., Univ. of Notre Dame; Jan. 1941 to date with Giffels & Vallet Inc., Chas. W. Cole & Son, Archts. and Engrs., as Draftsman and Instrumentman.

BOYD, EDWARD SUTHERLAND, Long Island City, N.Y. (Age 27) (Claims RCA 2.8) Dec. 1940 to date with Ebasco Services, Inc. (formerly Phoenix Eng. Co.), on hydro-electric power-plant design; previously with The Texas Co. on design of concrete foundations; with H. W. DelGaudio, Cons. Engr., as Eng. Inspector on Vladeck Housing Project; with Hildreth & Co. New York City.

DARLING, PHILIP VAN INGEN, Arlington, Va. (Age 26) June 1938 to date on city planning and housing for U.S. Housing Authority, etc.

DUBROW, MORGAN DAVIS, Iowa City, Iowa (Age 25) Sept. 1936 to Sept. 1939 and Aug. 1940 to date with U.S. Waterways Experiment Station, as Jun Eng. Aide, Asst. Eng. Aide, Eng. Aide, and (since Jan. 1941) Jun. Engr.; in the interim Eng. Aide, U.S. Engr. Sub-Office, St. Paul Dist., Iowa City.

FISHER, VOIGT RAYMOND, Shiprock, N.Mex. (Age 28) (Claims RCA 1.5) April 1937 to date with CCC-ID, Navajo Service, Window Rock, Ariz., as Trail Locator, and (since Dec. 1939) Jun. Engr.; previously with Kansas State Highway Comm.

GENTRY, BRUCE AGAR, Honolulu, Hawaii (Age 25) (Claims RCA 2.3) Feb. 1941 to date Asst. Engr., U.S. Engr. Dept., Civil Branch, Highway Dept.; previously Project Engr., Standard Fruit & Steam Ship Co.; Transitman, J. G. White Eng. Corporation.

GIPE, JAMES, Honolulu, Hawaii. (Age 25) March 1941 to date Senior Civ. Draftsman (Civil Service), USED; previously Rodman and on other duties, City Engr.'s Office, and Chainman, Great Northern Ry., Great Falls, Mont.

MEJIA URUENA, LORENZO, Ithaca, N.Y. (Age 26) Sept. 1940 to date graduate student, Cornell Univ.; previously Engr. with Pizano Hernandez & Gutierrez, Bogota, also, Asst. Prof., School of Eng., Colombia.

NOBLE, GILBERT GEORGE, Topeka, Kans. (Age 29) (Claims RCA 1.5) Jan. 1935 to date with Kansas Highway Comm., as Rodman, Inspector, Instrumentman, Asst. Engr., and (since May 1941) Associate Engr.

PETERSON, LEE RICHARD, Columbus, Ohio. (Age 23) 1939 B.S., Kans. State Coll.; Sept.

1940 to date Jun. Hydr. Engr., U.S. Geological Survey; July 1939 to Sept. 1940 Chainman, The Texas Co.

VILLEMONTE, JAMES RICHARD, State College, Pa. (Age 29) (Claims RCA 2.9) April 1941 to date Research Associate and Instructor, Pennsylvania State Coll.; June 1935 to Oct. 1936, June 1937 to Feb. 1940 and July to Sept. 1940 with Wisconsin Highway Comm., as Senior Eng. Aide, Jun. Asst. Highway Engr., and Jun. Bridge Draftsman; in the interim Research Asst. and graduate student, Univ. of Wisconsin, and Field Engr. and Representative, Wisconsin Trades Practice Comm.

1941 GRADUATES

UNIV. OF ARIZ.
(B.S. in C.E.)

	Age
ARMSTRONG, DONALD PAUL	(25)
CURTIS, CARL LAMAR	(23)
FRAEDRICH, EDWARD CARLILE	(24)
GRISWOLD, WILLIAM SHERIDAN	(23)
MCBRIDE, GRAHAM LOADER	(22)

BUCKNELL UNIV.
(B.S. in C.E.)

CARD, FLOYD EBER	(30)
KAUFFMAN, WILLIAM RICHARD	(22)
ROTHERMEL, GLEN URBAN	(22)

CLARKSON COLL. TECH.
(B.C.E.)

CAIN, MORRISON GRIFFIN, JR.	(23)
SHARLOW, CHARLES RAYMOND	(22)

CLEMSON A. & M. COLL.
(B.C.E.)

PITCHFORD, CHARLES WESLEY	(20)

COLO. STATE COLL.
(B.S. in C.E.)

ADAMS, SHAROLD EVERETT	(30)
BENNETT, JOSEPH HENRY	(27)
BREES, GLEN EDWARD	(23)
BROWN, MAURICE WESLEY	(22)
DOYLE, JAMES LAFAYETTE	(27)
GUNN, ARTHUR WENDELL	(27)
JENSEN, CARL FREDRICK	(22)
LARKINS, NORMAN FRANK	(26)
MATHIAS, WARD EUGENE	(23)
NORDELL, CHARLES ARTHUR	(21)
PORTER, LLOYD EARL	(23)
TAYLOR, DONALD BURDETTE	(22)
TORMEY, JACK CALE	(23)
WALKER, CLIFFORD CLAY	(22)
WHITNEY, WILLIAM JAMES	(24)

COLUMBIA UNIV.
(B.S. in C.E.)

BOGARDUS, ROBERT KENT	(21)

CORNELL UNIV.
(B.C.E.)

CLARK, ROBERT TAYLOR	(21)

UNIV. OF FLA.
(B.C.E.)

BRAKEFIELD, CHARLES MARTIAL, JR.	(23)
CLARKE, JOHN LESLIE, JR.	(24)
WALKER, DAN	(24)

GA. SCHOOL TECH.
(B.S. in C.E.)

MINGLEDORFF, FRANK CRUM	(24)

IOWA STATE COLL.
(B.S. in Civ. Eng.)

KIDO, KUNIO	(23)

UNIV. OF KY.
(B.S. in C.E.)

ROBARDS, WOODFORD LEE	(22)

MANHATTAN COLL.
(B.C.E.)

KINNEY, JOHN ERWIN	(23)

UNIV. OF MD.
(B.S. in C.E.)

BOOZE, WILLIAM CHARLES	(23)
DAVIDSON, DONALD CHATTERSON	(24)
HODGINS, LAWRENCE JUDSON, JR.	(20)
YOUNG, CHARLES MELL	(21)

MISS. STATE COLL.
(B.S. in Civ. Eng.)

CLARK, THOMAS ALEXANDER	(22)
DEVALLE, JOEL WELBORN	(23)
FURR, HOWARD LEE	(25)
HALE, MALCOLM DAVID	(21)
HAND, JOHN FRED	(22)
HOLTON, HARRY HAMILTON	(20)
MONTGOMERY, JOSEPH THOMSON, 3D	(20)
PATTON, JAMES CARSON	(20)
PRIESTER, VIRGIL DOUGLAS	(22)

UNIV. OF MISS.
(B.S.C.E.)

KIMMONS, GEORGE HARVEY	(22)
SANDERS, HERBERT CARL	(22)
SMITH, LLOYD ROBERT	(23)
TATUM, JOHN HERVEY	(21)

MO. SCHOOL OF MINES AND MET.
(B.S. in Civ. Eng.)

ALSMEYER, WILLIAM CARL	(27)
BOURNE, WILLIAM HUNT	(20)
BOYD, ROBERT KELSO	(22)
BROOKSHIRE, ROBERT RAYMOND	(22)
DRESTE, JEROME PHILIP	(22)
HALL, JANE CHARLOTTE (Miss)	(21)
HARDINE, KENNETH LAVERNE, JR.	(22)
STOCKTON, HERBERT REECE	(22)
TRISCH, DONALD LEE	(23)

OKLA. A. & M. COLL.
(B.S. in Civ. Eng.)

DAWSON, LEWIS DECKER, JR.	(20)

UNIV. OF OKLA.
(B.S. in Civ. Eng.)

FORD, NATHANIEL	(23)

PURDUE UNIV.
(B.S. in Civ. Eng.)

ANDROS, CARL	(23)
APSEY, FREDERICK WILLIAM, JR.	(23)
CAMPBELL, GEORGE RODGERS	(22)
CASH, MITCHELL	(22)
COMER, GUY WILLIAMSON, JR.	(24)
ERICK, WILLIAM DEA	(21)
ERICKSON, WILLIAM FRANK	(24)
FREESE, JAMES OTIS	(22)
FREY, GEORGE JOHN, JR.	(21)
HARRIS, GALEN STANLEY	(23)
HORTH, ROBERT JAMES	(21)
ILLE, FRANK KEITH	(21)
KETTLER, ALFRED WILLIAM, JR.	(21)
KIRK, CHARLES THOMAS	(21)
KRULL, ROBERT ALWIN	(22)
LEWIS, ALBERT DALE MILTON	(21)
MCCAMMON, LEWIS BROWN, JR.	(21)
MCCOLGIN, WILLIAM ELSWORTH	(22)
MANTON, JAMES JAY	(22)
MARTINEK, JAMES FRANKLIN, JR.	(23)
MASS, MARVIN LEON	(21)
MYERS, CLARENCE HAROLD	(25)
NORRIS, MAX LEROY	(23)
RIETH, WILLIAM NICHOLAS	(22)
SAMS, ALLEN LEVERNE	(24)
SLATER, JOHN PITTENGER	(23)
STEWART, CLYDE LOUTON, JR.	(23)
STEWART, GORDON AUGUSTUS	(30)
SWITZER, JOHN MACGREGOR	(23)
WARREN, ROBERT ALEXANDER	(22)
YOCHEM, ELVIN JOSEPH MEYER	(20)

ROSE POL. INST.
(B.S. in Civ. Eng.)

HARPER, GEORGE CLARE, JR.	(21)
HOGAN, RAYMOND CARL	(22)
KLATTE, ALBERT LADD	(24)
MCGURK, SAMUEL ROGERS	(21)
MCWILLIAMS, CARLTON LEWIS	(22)

RUTGERS UNIV.
(B.S. in Civ. Eng.)

BOYARIN, DAVID	(21)
DEL MASTRO, ANTHONY JOSEPH	(23)
PETERS, STANLEY BRODRICK	(21)
RACITI, FRANK FRONTINUS	(25)

UNIV. OF SANTA CLARA
(B.C.E.)

FRIEDENBACH, KENNETH JOSEPH	(21)
PARDINI, CAESAR JOSEPH	(22)
VON TOBEL, GEORGE WOODRUFF	(23)

UNIV. OF S.C.
(B.S. in C.E.)

HORTON, RALPH MCKINLEY, JR.	(22)

SYRACUSE UNIV.
(B.S. in C.E.)

BROWN, KENNETH ROOSEVELT	(21)
BURNS, LEO EDWARD	(22)
COTTRELL, JACK WORTHINGTON	(22)
FARLEY, JOSEPH RAYMOND	(29)
VERMILYA, JAMES LEWIS	(23)

TEX. TECH. COLL.
(B.S. in C.E.)

FOOTE, NORMAN C.	(22)
GRAY, HERBERT MANES	(20)
JOHNSON, OBER VAUGHN	(26)
PARRISH, CLIFFORD MARION	(22)
PATTERSON, JOHN LEO	(24)

THAYER SCHOOL OF CIV. ENG.
(C.E.)

BLY, ERNEST RICHARD (Also 1939 A.B., Dartmouth Coll.)	(24)
DAVIDSON, FREDERIC ARMSTRONG, JR. (Also A.B., Dartmouth Coll.)	(22)
ESPY, JAMES BRUCE (Also 1940 A.B., Dartmouth Coll.)	(22)
ESTABROOK, FREDERICK DICKINSON	(24)
HAYDEN, BUFORD MARINE, JR. (Also A.B., Dartmouth Coll.)	(23)
PITZ, WILLOTT ARTHUR (Also 1940 A.B., Dartmouth Coll.)	(24)
THOMAS, JAMES AKIN, JR. (Also 1940 A.B., Dartmouth Coll.)	(23)

UTAH STATE AGRI. COLL.
(B.S. in C.E.)

BROWN, CHARLES FRANKLIN	(22)

UNIV. OF UTAH
(B.S.C.E.)

CURTIS, DAVID HAWS	(22)

UNIV. OF WASH.
(B.S. in Civ. Eng.)

BALKEMA, JOHN EDWARD, JR.	(24)
NORDIN, CLARENCE WALDEMAR	(26)
WALLACE, JOHN RANDALL, JR.	(25)

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men and Positions Available

These items are from information furnished by the Engineering Societies Personnel Service, with offices in Chicago, Detroit, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 141 of the 1941 Year Book of the Society. To expedite publication, notices of positions available should be sent direct to the Personnel Service, 31 West 39th Street, New York, N.Y. Employers and applicants should address replies to the key number, care of the New York Office, unless the word Chicago, Detroit, or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

CIVIL ENGINEER; M. Am. Soc. C.E.; age 48; New York state license; 25 years in charge of large construction operations—commercial, industrial, and monumental buildings; tunnels; airports; harbor improvements. Capable of supervising design as well as construction. C-853.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single, but exempt from draft; graduate of Tulane University, 1936; last four years on supervision of construction and design of highway bridges, wharves, bulkheads, and pile foundations. Have had graduate work in structural engineering and naval architecture; employed but available on short notice. C-854.

DESIGN

EXPERIENCED CIVIL AND HYDRAULIC ENGINEER; Assoc. M. Am. Soc. C.E.; graduate, B.S. degree; 22 years with consulting engineers and utilities in United States and Canada; 12 years in charge of drafting rooms on design of large projects. C-852.

GRADUATE CIVIL ENGINEER; Student Chapter member; age 23; M. Sc. in C.E. conferred in June 1941; four months experience in bridge office; three months on surveying party; specialized in structures in postgraduate work; seeks connection with good prospects for professional experience. C-855.

CIVIL AND ELECTRICAL ENGINEER; M. Am. Soc. C.E.; age 39; married; B.S.E.E.; C.E.;

M.S.C.E.; 5 years designing engineer in consulting engineer's office; 12 years in complete charge of design of all types of industrial plants and structures; also chief engineer of a reinforcing bar and structural company; licensed in civil, electrical, and mechanical engineering; desires responsible position. C-856.

Executive

Civil Engineer; Assoc. M. Am. Soc. C.E.; M.S. degree; 20 years experience: 7 years on surveys and general engineering and construction work; 13 years on investigation and planning development of rivers, waterways, and waterway commerce, involving economic studies, coordination, and administration; work as office engineer desired, South or South Central preferred. C-857.

Positions Available

Graduate Civil Engineer, who has had good experience in all phases of industrial building construction, to act as an inspector for architect. Must know the mechanical and electrical phases of construction. Salary, $2,700–$3,000 a year. Headquarters, New York, N.Y. Y-8155.

Structural and Concrete Designers, preferably with experience in heavy building construction, power plants, etc. Salary, $3,000–$3,600 a year. Also desire electrical designer who has had power plant experience and substation design work. Salary, $3,000–$3,600 a year. Location, Philadelphia. Y-8189.

Valuation Engineer, Civil, who has had some experience. Also desire a young engineer who has had some structural experience. Salary, $2,400 a year. Location, South. Y-8198.

Draftsman, Civil Engineer, for the building and property department of a large industrial company. Work, at present, will be primarily map drafting of present properties; also some work on the design of new buildings. Salary, $1,680–$3,000 a year, depending upon experience. Location, Ohio. Y-8237-R59C.

Designers experienced in structural steel and reinforced concrete. Applicants should have had experience in the design and construction of industrial buildings. Salary open. Location, Pennsylvania. Y-8265.

Reinforced Concrete Structural Designers who are competent and experienced in this field. Sales personality and construction knowledge are desirable but not essential. Will be required to call on architects, engineers, and contractors, and must be able to put his knowledge into words. Salary open. Location, New York metropolitan area. Y-8269.

Designer, graduate civil engineer, who has had about ten years' experience in the design of structural steel and reinforced concrete bridges. Salary, $3,300 a year. Permanent position. Location, New York metropolitan area. Y-8273.

Inspectors of Construction, young civil engineers, who have had one to three years' experience in inspection work. Salary, $1,820–$2,080 a year for forty-hour week with time and a half for overtime. Location, New York, N.Y. Y-8292.

Construction Estimator, 37–47, who has had considerable experience with a general contractor. Must be able and capable of assuming the full responsibility of competitive bid estimating. Material take-off man not wanted; applicant must know material and labor costs. Position permanent. Salary open. Location, New York, N.Y. Y-8308.

Designers and Draftsmen, 30–45, experienced in water supply and sewerage disposal. Salaries, foreign, $4,600; New York, $3,200 a year. Locations, Central America and New York. Also desire topographical draftsman experienced in mapping fairly rugged country. Salary, $2,700–$3,200 a year. Location, Central America. Y-8310.

Specification Writer who has had some experience with a general contractor. Must be acquainted with dock and mill construction, concrete and steel. Salary, to $4,000 a year. Position temporary, but possibility of permanency. Location, New York, N.Y. Y-8315.

Engineers. Executive superintendent experienced in highway and airport construction, to take charge of several construction jobs. Salary, $7,500 a year. Superintendents of construction, 35–50, with similar experience for individual job. Salary, $5,000–$6,000 a year. Job engineers and inspectors of construction with above experience. Salary, $3,600–$3,800 a year. Location, Central America. Y-8338.

Structural Steel Designers experienced in layout of steel mills or structural work in manufacturing or industrial plants. Salary, $3,600 a year. Location, New Jersey. Y-8356.

Engineers. Draftsmen-Designers experienced on heavy marine piers, quay walls, etc. Salary, $1,460–$4,420 a year. Pipe layout engineer experienced in water-air plumbing. Salary, $4,160–$4,420 a year. Structural designer experienced on concrete and steel, mainly concrete. Salary, $4,420–$4,680 a year. Structural draftsmen, preferably with marine experience. Salary, $3,640–$3,900 a year. One-year contracts. Location, West Indies. Y-8360.

Recent Graduate Civil Engineer who has had some experience in the office of a general contractor. Will be required to do simple quantity estimates and drafting work. Salary, $1,500–$2,080 a year. Position permanent. Location, New York, N.Y. Y-8368.

Estimators who have had considerable experience in estimating chemical plant construction and equipment. Must be qualified to assume responsibility. Salary, $4,000 a year. Location, New York, N.Y. Y-8370.

Estimators, Civil Engineers, familiar with general construction. Mechanical estimators experienced in miscellaneous metal trades, iron, bronze, etc. Also estimator on plumbing, heating and ventilating. Salaries, $3,900–$5,200 a year. Locations, New York and foreign. Y-8375.

Civil Engineer who has had six to eight years' experience in the field of railroad and track design. Salary, $3,200 a year to start. Location, South. Y-8403.

Chief Draftsman who has had experience on heavy construction work, particularly marine structures, piers, docks, quay walls, and kindred structures. Applicant must be temperate in his habits. Salary, $6,500 a year. Location, West Indies. Y-8408.

Civil Engineers. Designer experienced in heavy construction. Must have worked for a contractor. Salary, $4,420 a year. Temporary, eight months to one year. Also inspectors and surveyors. Any pile drawing or marine experience desirable but not essential. Salary, $2,600 a year. Location, South. Y-8411.

Surveyor who is capable of taking the responsibility of furnishing line and grade stakes on construction job. Salary, $3,120 a year. Duration, about four months. Location, New York State. Y-8417.

Chief of Party, experienced civil engineer, who has had at least five years' experience in similar capacity for contractor. Salary, $4,420 a year. Duration, one year. Location, foreign. Y-8430.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room will be found listed here. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

Air Raid Precautions Handbook No. 5, Structural Defence, 1 ed., issued by the Home, Office, Air Raid Precautions Dept. London, His Majesty's Stationery Office, 1939. 58 pp. diagrs., charts, tables, 13 × 8 in., paper, 2s. (Obtainable from British Library of Information, 620 Fifth Ave., New York, 60 cents.)
Fundamental principles and data derived from research and experiment are presented in this handbook. In the first two chapters the theoretical and practical effects of explosive bombs are considered in some detail. The subsequent chapters deal with the requirements and principles of design of structures to resist such attacks, both for the construction of new buildings and the adaptation of existing ones.

(An) Engineers' Manual of Statistical Methods. By L. E. Simon. John Wiley & Sons, New York, 1941. 231 pp., illus., diagrs., charts, tables, 10 × 6½ in., cloth, $2.75.
This book is a summary of certain working parts of the sciences of probability, statistics, and logic, and is designed to assist the practical man in industrial or engineering work. Since the book is written primarily for use in an ordnance school for instruction in statistical techniques, the illustrative examples are generally taken from standard procedures or research at arsenals and proving grounds. The principles are, however, applicable to other inspection or quality control problems.

Great Britain. Dept. of Scientific and Industrial Research. Building Research. Wartime Building Bulletin No. 14. Centerless Arch Designs. His Majesty's Stationery Office, London, 1941. 15 pp., illus., diagrs., charts, tables, 11 × 8½ in., paper. (Obtainable from British Library of Information, 620 Fifth Ave., New York, 30 cents.)
Continuing the material on centerless arch work described in Bulletin No. 6, the present bulletin gives several designs for segmental arch structures and notes and curves for the design of other segmental arch rings. For illustration, the application of the system to a factory scheme is discussed.

Methods of Study of Sediments. By W. H. Twenhofel and S. A. Tyler. McGraw-Hill Book Co., New York and London, 1941. 183 pp., illus., diagrs., charts, tables, 9½ × 6 in., cloth, $2.
The authors present a brief, non-mathematical, yet complete treatment of methods of study of sediments. Standard methods of sampling for various types of sediments are described, methods of analysis are given, and various forms of graphical representation of the characteristics of sediments and sedimentary rocks are shown. Coal and oil shales receive particular attention, and further references accompany each chapter.

Public Works Engineers' Yearbook, 1941. American Public Works Association, Chicago, 1941. 424 pp., illus., diagrs., charts, tables, 9 × 5½ in., cloth, $3.50.
The papers presented at the 1940 Public Works Congress and the Western Regional Conference are included in the current volume of this yearbook. They are broadly grouped under the following headings: Public works administration; city and regional planning; streets and highways; traffic control; and sewerage and sewage disposal. Other important material and the business proceedings of the American Public Works Association are also included.

Schriftenreihe der Arbeitsgemeinschaft für Technikgeschichte des Vereines deutscher Ingenieure, Heft 15. Die Nassbaggerung bis zur Mitte des 19. Jahrhunderts, by H. Conradis. VDI-Verlag, 1940. 157 pp., illus., diagrs., tables, 12 × 8 in., paper, 10 rm. (9 rm. to members).
The history of the development of dredging equipment is covered up to the middle of the nineteenth century. Primitive and unusual types are discussed as well as the more familiar wheel, dipper, and endless-chain types which are treated with more detail. There are many illustrations, a discussion of the derivation of various German, English, and French words for such equipment, and a considerable bibliography.

Soil Mechanics. By D. P. Krynine. McGraw-Hill Book Co., New York and London, 1941. 451 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $5.
This book presents the principles used in the design, construction, and maintenance of foundations of structures and structures made of earth material. Engineering applications of these principles are discussed; field and laboratory soil investigations are described; and the settlement of structures—its causes, prevention, and damage—are considered. The physical properties of soil materials are studied, and many important conceptions and principles, such as idealized earth masses and continuity of strains, are fully dealt with. Problems and references accompany each chapter.

Tables of Sine, Cosine and Exponential Integrals. Vol. 2. Prepared by the Federal Works Agency, Work Projects Administration for the City of New York; conducted under the sponsorship of, and for sale by, the National Bureau of Standards, Washington, D.C., 1940. 225 pp., tables, 11 × 8 in., cloth, $2; advance payment required.
The functions indicated are tabulated in this volume over the range between 0 and 10 at intervals of 0.001. Differences have been listed for purposes of interpolation, although for the range from 0 to 2, Vol. I should be consulted for greater accuracy in this respect. Several supplementary tables and various reference lists are included.

Textbook of Geology, Pt. 2. Historical Geology, 4 ed. By C. Schuchert and C. O. Dunbar. 4 ed., largely rewritten. John Wiley & Sons, New York, 1941. 544 pp., illus., diagrs., charts, maps, tables, 9 × 6 in., cloth $4.
As in previous editions, the history of the geologic changes on the earth is presented chronologically. A prologue of several chapters presents basic conceptions for interpreting geological records, and the whole subject is treated in a simple manner for the beginning student. In order to take account of new facts the subject matter has been considerably revised.


Projects
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Current Periodical Literature

Abstracts of Magazine Articles on Civil Engineering Subjects

Selected items for the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in the Engineering Societies Library. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page to members of the Founder Societies (30 cents to all others), plus postage.

CITY AND REGIONAL PLANNING

CITY PLANNING. Influencia do factor heliotermico na urbanizacao, A. Fernandes and P. Bravo. *Ordem dos Engenheiros—Boletim*, vol. 4, no. 47, Nov. 1940, pp. 407–427. Influence of factor of solar heat on planning of cities and towns; mathematical discussion.

FUNCTION IN GOVERNMENT. For More Effective Urban Planning. *Am. City*, vol. 56, no. 5, May 1941, pp. 43–44. Abstract of findings and conclusions from new book, *Planning Function in Urban Government*, by R. A. Walker.

LONDON, ENGLAND. London of Future, W. H. Ansell. *Roy. Soc. Arts—J.*, vol. 89, no. 4585, Apr. 18, 1941, pp. 316–327, (discussion) 327–333. Discussion on replanning of London; author recommends not a new London, but vastly improved old London, retaining every architectural treasure together with modern contribution which present opportunity has made possible; London's faults; slums and industrial areas; replanning commercial areas; city churches; architectural treatment.

ZONING. How Much Commercial Area Should Be Provided for in Zoning Ordinances? H. Bartholomew. *Planners' J.*, vol. 7, no. 1, Jan.–Mar. 1941, pp. 20–24, (discussion) 25–30. Review of zoning practice in Middle West municipalities, particularly in Evanston, Ill.; comparison of zoned and developed commercial frontage by districts.

CIVIL ENGINEERING

GEOPHYSICS. Exploration Geophysics, J. J. Jakosky. *Can. Min. J.*, vol. 62, nos. 4 and 5, April 1941, pp. 239–242, and May, pp. 309–313. April: Economics of petroleum geophysics; comparison of wells located with and without technical evidence; geophysical methods in mining. May: Metallic and non-metallic bedded deposits; miscellaneous non-metallic deposits; choice of methods; geophysical methods in civil engineering; examination and location of dam sites; reservoir sites; highway engineering. Bibliography.

DAMS

AUSTRALIA. Construction of Barrages River, Murray Mouth, South Australia. *Commonwealth Engr.*, vol. 28, no. 6, Jan. 1, 1941, pp. 181–184. Features of five new diversion barrages, founded on piles, ranging in length from 800 to 12,000 ft.

EARTH, COLORADO. Vallecito Dam Near Completion. *Western Construction News*, vol. 16, no. 4, Apr. 1941, pp. 111–112. Progress report on construction of Vallecito earth-fill dam across Pine River in Colorado, having maximum height of 129 ft and crest length of 4,000 ft; two-stage river diversion program; combining of outlet works and spillway 300 ft below dam; foundation conditions; embankment; outlet works; major items of construction equipment.

EARTH, WASHINGTON. Roofing Mud Mountain Dam. *Western Construction News*, vol. 16, no. 4, Apr. 1941, pp. 105–107. Construction of adjustable canvas test, measuring 280 ft in length by 196 ft at its widest point, designed to allow strict control of water content of earth core of Mud Mountain Dam in canyon of White River, near Enumclaw, Wash.

ITALY. Waterworks Practice in Italy, D. G. Davies. *Water & Water Eng.*, vol. 43, no. 538, Apr. 1941, pp. 116–119. Description of several Italian dams representing various types of construction; discussion of possibility of destruction of dams by aerial bombing. Bibliography.

RESERVOIRS, LINING. Construction of Earth Reservoir Embankments with Road Oil Linings, D. A. Blackburn. *Am. Water Works Assn.—J.*, vol. 33, no. 5, May 1941, pp. 876–882. Experience of Water Department of Pasadena, Calif., in using road oil in construction of fill on interior of reservoir embankments back of regular concrete slab lining; cut-and-fill procedure; completion of construction.

STEEL. Steel Dams, R. T. Logeman. *Western Soc. Engrs.—J.*, vol. 45, no. 6, Dec. 1940, pp. 313–317. Outline of originally modified design of buttressed steel dams with facing plates curved up and down instead of across dam; comparative economy of concrete gravity, steel-faced earth fill and all-steel types of dams.

WIDENING. Dam Bridge Widened Over Spillway. *Roads & Streets*, vol. 84, no. 4, Apr. 1941, pp. 37–39. Method and equipment used in widening highway U.S. 89 crossing Jackson Lake Dam at Moran, Wyo., 222 ft long; home radiators used to keep work at 50 deg until hardened.

FLOW OF FLUIDS

PIPES. Construction Design Chart—LXIV.—Flow of Water in Concrete Pipe, J. R. Griffith. *Western Construction News*, vol. 16, no. 4, Apr. 1941, p. 118. Construction of alinement chart based on Scobey formula, for computing flow of water in concrete pipe; numerical examples.

FOUNDATIONS

CAISSONS, STEEL. Caisson of Novel Design Used for Repairing Submerged Concrete. *Eng. News-Rec.*, vol. 126, no. 19, May 8, 1941, pp. 758–759. Principles of design and operation of steel caisson for use in making repairs to baffle piers on downstream apron of Bonneville Dam, recently built and launched at Portland and towed up Columbia River to dam; caisson is made of structural steel, sheathed with steel plates, and weighs 200 tons.

CLAY. Der Geschiebemergel als Baugrund, H. Kahl, J. Mauz, and F. Neumann. *Bautechnik*, vol. 19, no. 10/11, Mar. 7, 1941, pp. 113–115. Study of characteristics and results of tests of boulder-clay soil prevalent in northern Germany, with special reference to its suitability as foundation material.

FOOTINGS. Design of Spread Footings, I. F. Morrison. *Eng. J.*, vol. 24, no. 1, Jan. 1941, pp. 10–14. Mathematical discussion of theory of rational design of spread footings; phenomenon and causes of settlement; proportioning of footings; loading tests of bearing capacity.

PILE DRIVERS, INDOOR. "Dwarf" Pile Drivers Operate with Low Headroom Inside Building. *Construction Methods*, vol. 23, no. 4, Apr. 1941, pp. 68–69 and 118–119. Description of "dwarf" pile-driving rig, limited by working headroom of only $9^1/_2$ ft within industrial building, to drive more than 700 concrete-filled steel piles to depths of from 25 to 32 ft to support concrete ground floor of motor truck service structure in Long Island City, N.Y.; breaking old floor; concrete fill for pile casings.

SOILS, TESTING. Underwater Soil Samples Taken by Portable Test Rig, W. H. Jacobsen. *Eng. News-Rec.*, vol. 126, no. 13, Mar. 27, 1941, p. 475. Methods and equipment used in taking subaqueous soil samples at bridge sites, developed by bridge department of California Division of Highways; details of foundation testing rig.

HYDRAULIC ENGINEERING

SPILLWAYS, MODEL TESTING. Model Study of Spillway for Santee River Dam. *U.S. Waterways Experiment Station—Tech. Memo, No. 168-1*, Aug. 15, 1940, 66 pp., numerous supp. figs., tables, diagrs. Final report on laboratory tests of 1 to 36 and 1 to 50 models of sloping-deck Tainter gate spillway for Santee River Dam, in South Carolina, designed to have length of 3,400 ft and maximum discharge capacity of 800,000 cu ft per sec; technique of model testing.

HYDROELECTRIC POWER PLANTS

CALIFORNIA. Excavation for Parker Dam Power Plant, T. R. Johnson. *Reclamation Era*, vol. 30, no. 12, Dec. 1940, pp. 337–341. Methods and equipment used in excavation of some 350,000 cu yd of solid rock for foundation of Parker Dam power plant, south of Needles, Calif., including four penstock tunnels 27 ft in diameter.

HYDRAULIC TURBINES, FRANCIS. Francis Turbine Installations of Norris and Hiwassee Projects, G. R. Rich and J. F. Roberts. *Am. Soc. Mech. Engrs.—Advance Paper*, Mtg. Mar. 31–Apr. 3, 1941, 10 pp. Hiwassee turbine, having rated output of 80,000 hp at 190-ft head, is believed to be highest-powerd Francis wheel in eastern United States; Norris turbines are

identical in physical size with Hiwassee unit and have rated output of 66,000 hp at 164-ft head; considerations affecting selection of machines discussed, and principal features of design and acceptance testing described.

QUEBEC. Construction of Hydro-Electric Development at La Tuque, J. A. McCrory. *Eng. J.*, vol. 24, no. 2, Feb. 1941, pp. 54–63. Design and construction of 192,000-hp hydroelectric development on St. Maurice River at La Tuque, Quebec, including concrete gravity diversion dam 1,337 ft long; preparation of dam foundation; testing of model turbine runners; power efficiency curves for runner; diagram of electrical layout. Before Eng. Inst. Canada.

HYDROLOGY AND METEOROLOGY

EARTHQUAKE EFFECTS. Some Earthquake Damage Results, C. C. Huskison. *Agric. Eng.*, vol. 22, no. 4, Apr. 1941, pp. 149–150. Review of damage caused to irrigation canals, drainage ditches, roads, and bridges due to severe earthquake of May 18, 1940, in Imperial Valley in southern California and Yuma Valley in Arizona. Before Am. Soc. Agric. Engrs.

INLAND WATERWAYS

GREAT LAKES. Great Lakes Ports and Waterways, N. Y. DuHamel. *Military Engr.*, vol. 33, no. 188, Mar.-Apr. 1941, pp. 123–132. Commerce of Great Lakes ports in United States, their structures and equipment; breakwaters in Great Lakes ports; connecting waterways; regulation of lake levels; St. Lawrence waterway; lake surveys.

RIVERS, DIVERSION. Construction of Works for Diverting Hudson Bay Water Into Great Lakes System, T. H. Hogg. *Eng. & Contract. Rec.*, vol. 54, no. 4, Jan. 22, 1941, pp. 28–30 and 33. Description of works, costing $5,000,000, for diversion of Ogoki River, discharging through Albany River into Hudson Bay, into watershed of Lake Superior in Canada; features of dams, channel improvements, patrol works, etc.

RIVERS, IMPROVEMENT. River Training Works, J. L. Harrison. *Roy. Engrs. J.*, vol. 55, Mar. 1941, pp. 51–60. Principles of construction of revetments and guiding works for small rivers and creeks with special reference to conditions obtained in tropical India. Reprinted from *Indian Forester*, March 1940.

IRRIGATION

CANALS, CALIFORNIA. Construction Methods and Progress on Coachella Branch of All-American Canal, J. R. Lawrence. *Reclamation Era*, vol. 30, no. 12, Dec. 1940, pp. 335–336. Progress report on construction of first 40 miles of Coachella branch of All-American Canal in southeastern California, including 32 siphons and 4 automatic spillways.

UNITED STATES. Reclamation Engineering Number. *Reclamation Era*, vol. 30, no. 7, July 1940, pp. 189–209. Symposium on irrigation engineering work of U.S. Bureau of Reclamation, including following articles: Reclamation—Builder of Nation; Preconstruction—Project Planning; Designs and Specifications; Construction, Dams; Canals; Power Transmission Lines; Pumping; Auxiliary Works; Results.

LAND RECLAMATION AND DRAINAGE

CONTROLLED DRAINAGE. Controlled Drainage, D. H. Harker. *Agric. Eng.*, vol. 22, no. 4, Apr. 1941, pp. 139–142. Discussion of distinction between controlled drainage and subirrigation; principles of control of removal of hydrostatic water from soil, with special reference to muck lands in Michigan and Indiana. Before Am. Soc. Agric. Engrs.

MATERIALS TESTING

STRESSES, MEASUREMENT. Anwendung des Dehnlinienverfahrens bei Zelluloidmodellen, E. Siebel, W. Seufert and W. Steurer. *VDI Zeit*, vol. 84, no. 46, Nov. 16, 1940, pp. 889–890. Outline of European and American technique in use of brittle coatings for determining stresses in celluloid structural models; development of new special lacquer coating particularly suitable for this technique of stress determination.

PORTS AND MARITIME STRUCTURES

PIERS, WOODEN. "Sea-Going" Locomotive Cranes Expedite This Pier Job. *Ry. Age*, vol. 110, no. 13, Mar. 29, 1941, pp. 567–569 and 575. Description of large open-top timber pier erected by Baltimore and Ohio Railroad, at Baltimore, Md., construction of which was speeded up by use of three locomotive cranes; pier is 104 ft wide and is about 720 ft long on center line.

ROADS AND STREETS

AIRPORT RUNWAYS. Remarks Regarding Airports Runway Surfacings, H. H. Houk. *Roads & Streets*, vol. 84, no. 3, Mar. 1941, pp. 62–63. General discussion of airport runways by engineer of Washington national airport, including observations on surfacing elements and pavement surface conditions.

AIRPORTS, CONSTRUCTION. Soil Cement Runway for Army Airbase Placed with Enrichment in Top Inch. *Eng. News-Rec.*, vol. 126, no. 15, Apr. 10, 1941, pp. 531–533. Construction of soil cement runway at Westover Field, Northeast Army Air Base, Chicopee Falls, Mass., using 10% of portland cement well mixed for 6-in. depth and surface enriched by additional cement in top inch; heavy duty field cultivators and harrows, rotary tillers, sheepsfoot and tandem rollers, and bituminous distributor for application of water constituted principal equipment.

AUTOMOBILE DESIGN. Die Fahrtrichtungsstabilitaet des schnellfahrenden Kraftwagens, L. Huber. *Deutsche Kraftfahrtforschung*, no. 44, 1940, pp. 18–64. Behavior of automobiles running at high speed on curves, under various conditions; results of wind tunnel and other tests to determine lateral forces and moments of air and ground forces; purpose of investigation was development of automobile design which would maintain its direction and stability even against heavy lateral winds.

HIGHWAY ENGINEERING. Lessons for Canada, R. M. Smith. *Roads & Bridges*, vol. 79, no. 3, Mar. 1941, pp. 70, 72, and 90. Review of highway engineering practice of Germany, Italy, and Great Britain, drawing lessons for highway development in Canada; principles behind German roads; Italian highway developments; road problems in England; military use of roads; methods of financing roads. Before 1941 annual convention of Ontario Good Road Association.

HIGHWAY ENGINEERING, UNITED STATES. Facing Highway Future. *Better Roads*, vol. 11, no. 1, Jan. 1941, pp. 17–20 and 39–44. Symposium reviewing problems of highway engineering in United States for next decade, including following: Planning Will Fix Road Policies, T. H. MacDonald; How Fast Is Motor Use Growing?, C. H. Gray; Uniform Regulation Prime Need, T. R. Agg; Highways in Our Total Economy, C. M. Upham; Road Needs Are Better Known, R. E. Singer; Problems of Ways and Means, R. W. Crum; Facilitating Future Traffic Flow, S. J. Williams; Consider Patterns of Land Use, H. R. Pomeroy; Guard Capital Investment, R. H. Baldock; Plan for Needs of Traffic, H. S. Simpson; Must Restore Public Participation, J. A. Long; Study Entire Road Picture, H. C. Bradshaw; and Counties Confront Major Problems, L. V. Belknap.

HIGHWAY SYSTEMS, MISSISSIPPI. Rebuilding Coastal Route in Mississippi, G. W. Thompson. *Roads & Streets*, vol. 84, no. 3, Mar. 1941, pp. 54, 56, 58, and 60. Methods and equipment used in reconstruction of 20-year-old, 20-ft wide U.S. Route 90 in Harrison County, Miss., converting it into modern dual-lane highway; work preliminary to reconstruction; highway design and construction features.

HIGHWAY SYSTEMS, UNITED STATES. Boston-Washington Superhighway. *Eng. News-Rec.*, vol. 126, no. 15, Apr. 10, 1941, pp. 550–551. Discussion on preliminary work for construction of 405-mile toll superhighway from Boston to Washington at cost of $253,000,000.

NATIONAL DEFENSE, CAMOUFLAGE. Camouflage with Coloured Cement, J. Singleton-Green. *Surveyor*, vol. 98, no. 2546, Nov. 8, 1940, pp. 229–231. Review of methods of camouflaging using colored cements; mixing and using cement paint; using colored cement for camouflaging concrete surfaced road. Bibliography.

NATIONAL DEFENSE. Elements of Hill Road Making, L. F. R. Kenyon. *Roy. Engrs. J.*, vol. 55, Mar. 1941, pp. 31–44. Non-technical discussion of design and construction of temporary military roads in hilly topography in semi-developed countries, including construction of temporary bridges.

NATIONAL DEFENSE. Fighting Mud at Camp Wallace. *Eng. News-Rec.*, vol. 126, no. 15, Apr. 10, 1941, pp. 544–546. Use of seven million board feet of planking for corduroy roads, on flooded muddy sites of Camp Wallace, at Hitchcock, Tex.; drainage and flood protection; rail and timber road access.

ROAD MATERIALS, SOILS. Effect of Grading and Admixtures, J. B. Garneau and C. E. Beland. *Roads & Streets*, vol. 84, no. 3, Mar. 1941, pp. 64, 67–68, 70, 72, 74, 76, 78, and 80. Results of Canadian experimental study of soil base course mixtures, with special reference to military aspects of highway construction; studies of variable gradations; examples of calculation of plasticity index; types of soil stabilization, testing procedures; effect of admixture on compressive strength; effect of grading on total water absorption; effect of calcium chloride on total water absorption.

SOILS, EROSION. Erosion Control Reduces Road Upkeep, C. C. Tevis. *Eng. News-Rec.*, vol. 126, no. 9, Feb. 27, 1941, pp. 339–341. Study of costs of highway maintenance demonstrating economy of erosion control including channelization, slope retards, and planting with vegetation; construction provisions that reduce erosion; erosion control in cuts; fill and shoulder protection; maintenance costs due to erosion.

SOILS, EROSION. Headwater Highways—New Forest Menace, B. Frank. *J. Forestry*, vol. 39, no. 3, Mar. 1941, pp. 291–296. Discussion of effect of headwater highways on runoff and erosion, particularly in forested areas. Bibliography.

STABILIZATION. Bituminous Soil Stabilization, W. L. Campbell. *Roy. Engrs. J.*, vol. 55, Mar. 1941, pp. 89–103, supp. plate. Principles of

stabilization of road bases in bituminous materials; function of bituminous stabilizer; water resistance test; frost resistance; methods of mixing, spreading, and consolidation; potentialities of soil stabilization; determination of bearing strength by cone penetrometer; elutriation test.

Stabilization. Soil Technology in Modern Highway Construction, N. W. McLeod. *Roads & Bridges*, vol. 79, no. 3, Mar. 1941, pp. 28 and 111–114. Application of recent advances in soil technology to modern highway construction; soil classification; fundamentals of soil drainage; principles of subgrade construction; fundamentals of base course construction and wearing surfaces; use of asphalt in base course stabilization; effect of bitumen in reducing moisture absorption of mechanically stabilized base course mixtures.

Stabilization. Stabilization with Asphaltic Emulsions, J. R. Roberts. *Roads & Bridges*, vol. 79, no. 3, Mar. 1941, pp. 33 and 96–99. Advantages of road stabilization with asphaltic emulsions; construction procedure; mechanically stabilized bases; macadam bases; pre-mixes and road mixes; low-cost surfaces; double surface treatments; armor coats; dense-graded surfaces; retreads; gravel road mixes.

Standards. California Revises Its Standard Specifications for Highway and Bridge Work. *Western Construction News*, vol. 16, no. 3, Mar. 1941, pp. 82–84 and 97. Revised specifications for seal coats, road and plant mix surfacing, pavements, concrete and timber structures.

Street Lighting, War Time. Wartime Street Lighting. *Gas J.*, vol. 232, no. 4048, Dec. 18, 1940, pp. 514–516. Study of fundamental requirements; behavior of eye in weak light; visual sensitivity at low levels of illumination; applications. From Illum. Eng. Soc.

Widening. Widening of Shoulders on Main Highways, E. H. Lockridge. *Pub. Works*, vol. 72, no. 1, Jan. 1941, pp. 16–18. Methods developed by Indiana State Highway Commission for widening of shoulders of main highways for purpose of providing turnouts and storage space.

SEWERAGE AND SEWAGE DISPOSAL

Activated Sludge. Suspended Solids Balance in Purification of Sewage by Activated Sludge, C. Lumb. *Surveyor*, vol. 98, nos. 2548 and 2549, Nov. 22, 1940, pp. 256–257, (discussion) Nov. 29, pp. 274–276. Results of experimental study at sewage works of Halifax, England, of quantitative relation between suspended, colloidal, and pseudo-colloidal matter in tank effluent and excess activated sludge, formed from such effluent by bio-aeration or bio-filtration. Before 1940 annual meeting of North-Eastern Branch of Institute of Sewage Purification.

Camps, Military, Sanitation. Quartermaster Corps Instructions and Standards for Camps, Cantonments and Air Fields. *Pub. Works*, vol. 72, no. 1, Jan. 1941, pp. 33–34. Information and instructions for constructing quartermasters and engineers in connection with water supply, sewerage, drainage, and roadways.

Chemical Process. Chemical Coagulation of Sewage—XII—Iron Salts and Lime, H. W. Gehm. *Sewage Works J.*, vol. 13, no. 2, Mar. 1941, pp. 239–248. Results of experimental laboratory study of relative effectiveness of processes of chemical treatment of sewage employing iron salts. Bibliography.

Chlorination. Variations in Chlorine Demand of Buffalo Sewage, G. E. Symons, R. W. Simpson, and S. R. Kin. *Sewage Works J.*, vol. 13, no. 2, Mar. 1941, pp. 249–264. Analysis of data collected in 27 months of sewage chlorination studies which were inaugurated with beginning of sewage treatment at Buffalo; variation in chlorine demand with sewage temperature; hourly variations in chlorine demand by seasons; effect of storm flows on chlorine demand of raw sewage; effects of industrial peak loads on chlorine demand of raw sewage. Bibliography.

Detroit, Mich. Public Health Aspects of Sewage Treatment in Detroit, W. M. Wallace and A. B. Morrill. *Sewage Works J.*, vol. 13, no. 2, Mar. 1941, pp. 265–269. Review of sewage disposal processes practiced in sewage disposal plant of Detroit, Mich., where diluting stream flow is 300 times greater than average sewage flow.

Disposal Plants, Equipment. Automatic pH Recording Controls Sludge Filtration, A. J. Deck and L. M. Johnson. *Sewage Works Eng. & Mun. Sanitation*, vol. 12, no. 3, Mar. 1941, pp. 167–169. Report on experiments on automatic pH recording carried out at Southwest Sewage Treatment Works of Chicago, Ill.; sketch showing principles of automatic pH recorder and proportioning controls; description of immersion-type glass-electrode assembly.

Disposal Plants, Grit Chambers. Design and Operation of Grit Chambers, A. E. Berry. *Water & Sewage*, vol. 79, no. 1, Jan. 1941, pp. 22–24 and 53–54. Principles of design and operation of grit chambers for sewage disposal plants; effects of grit; importance of grit removal; procedure for grit chamber design in Canada; theory of sedimentation; regulation of velocity; grit-washing velocities; methods for washing and removing grit in Canadian sewage disposal plants.

Industrial Waste. Pre-Treatment of Trade Effluents. *Surveyor*, vol. 98, nos. 2545 and 2546, Nov. 1, 1940, pp. 209–212 and Nov. 8, pp. 225–227. Abstract of symposium and discussion before British Institute of Sewage Purification; nature of preliminary treatment; guiding principles; recovery of chromate; neutralization of acid wastes; iron sludge; cyanide wastes; effect of metallic wastes on sludge treatment; oil and grease wastes; limitation of constituents; elimination of avoidable waste; classification of trade effluents; gas liquors; need for standardized procedure.

Military Camps, Sewage Disposal. Sewage Treatment Plants for National Defense Projects. *Pub. Works*, vol. 72, no. 2, Feb. 1941, pp. 9–10 and 39–41. Condensed version of report on sewage treatment plants prepared by Metcalf & Eddy and Greeley & Hansen and issued by Engineering Branch, Construction Division, Office of Quartermaster General; typical layout of sewage treatment plant for national defense project; list of sewage treatment plants as installed in major cantonments; sewage quantities and characteristics; bases of design or plant loadings; indicated costs; scum handling; comments on equipment; filter fly control.

Sewage Analysis. Calendar, Clock and Sewage Samples, W. F. Crohen. *Pub. Works*, vol. 72, no. 1, Jan. 1941, pp. 20–22 and 36. Results of experimental study of effect of time of day, week, or month on catch samples and how to allow for them in analyzing sewage and effluents.

Sewage Disposal, Europe. Sewage Treatment Abroad Affected by War and Economic Conditions, G. Ornstein. *Sewage Works Eng. & Mun. Sanitation*, vol. 14, no. 3, Mar. 1941, pp. 163–166. Effect of war and economic stress on sewage disposal in Europe, utilization of sewage and its by-products for growth of food, fish, etc.; economy of sewage treatment and preservation of stream purity in England and Germany; chemical precipitation of highly concentrated sewages and industrial wastes by recovery of coagulants; activated sludge in Holland; industrial wastes in Germany.

Sewers, Deposits. Slopes of Sewers, and Deposits Therein. *Sewage Works Eng. & Mun. Sanitation*, vol. 12, no. 3, Mar. 1941, pp. 182–183. Discussion by sewage disposal plant operators on trouble from deposits in sewers attributed to flat slopes and low velocities; minimum slope advisable on 8, 12, and 15-in. sewer pipe in order to prevent objectionable deposits.

SLUDGE. Dewatering of Sludge by Vacuum Filtration, L. W. Van Kleeck. *Pub. Works*, vol. 72, no. 2, Feb. 1941, pp. 14–16 and 38–39. Discussion of methods and equipment for removing excess moisture from sewage sludge by means of vacuum filtration; description of filters; operation of filters; disposal of filter cake; control of filtration; design considerations in filtration of primary sludges; major factors affecting successful filtration.

SLUDGE. Heat Treatment as Aid to Sludge Dewatering—Ten Months' Full-Scale Operation, C. Lumb. *Surveyor*, vol. 98, nos. 2550 and 2551, Dec. 6, 1940, pp. 287–291, (discussion) Dec. 13, pp. 308–312. Features and results of 10 months' operation of sewage sludge dewatering plant of Halifax, England, designed to deal with 25,000 gal of raw sludge, containing approximately 5:1 by weight of dry humus to activated sludge solids; heat interchanger; capital cost; analysis of sludges; thermal efficiency, steam consumption, and heat recovery; disposal of liquor; analysis of liquor; cost of operation.

SLUDGE HANDLING. Saddlebags on Tractor Expedite Sludge Removal. *Eng. News-Rec.*, vol. 125, no. 23, Dec. 5, 1940, p. 745. Selection of method of transporting sludge from drying beds of sewage treatment plant of Aurora, Ill., Sanitary District; description of sludge handling tractor with side bins of 3-cu yd capacity that can be opened by means of hinge and lever arrangement to facilitate discharging.

WATER POLLUTION. Natural Purification of River Muds and Pollutional Sediments—I, G. M. Fair, E. W. Moore, and H. A. Thomas, Jr. *Sewage Works J.*, vol. 13, no. 2, Mar. 1941, pp. 270–307. First of series of articles on processes of natural purification by which river muds and pollutional sediments are stabilized, and effects of this purification upon supernatant water; composition of river muds and pollutional sediments; benthal decomposition; mathematical formulation of progress of decomposition; consolidation of deposits; upward diffusion of oxidizable substances. Bibliography.

STRUCTURAL ENGINEERING

BEAMS, CONCRETE. Construction Design Chart—LXIII. Concrete Beams in Tension, J. R. Griffith. *Western Construction News*, vol. 16, no. 3, Mar. 1941, p. 89. Construction of alinement chart for design of concrete beams reinforced for tension; numerical example.

BUILDING MATERIALS, CONSERVATION. Werkstoffeinsparung im Industriebau, K. Schaechterle. *VDI Zeit.*, vol. 84, no. 46, Nov. 16, 1940, pp. 891–895. Review of recent German practice in saving of structural materials, particularly steel; substitution of structural aluminum and reinforced concrete for steel; saving of materials through standardization; economic structural members; economic structural types for saving steel and concrete.

COLUMNS, DESIGN. Columns Subject to Uniformly Distributed Transverse Loads—Illustrating New Method of Column Analysis, J. A. Van den Broek. *Eng. J.* vol. 24, no. 3, Mar. 1941, pp. 115–120. Theoretical mathematical discussion of new method of column analysis, applicable to pin-ended column with uniform E and I, having at least one axis of symmetry and loaded transversely with uniformly distributed load in direction coincident with axis of symmetry.

FRAMED STRUCTURES, WELDED STEEL. Rigid Portal Frames, J. C. MacKain. *Welder*, vol. 12, no. 76, Sept.-Oct. 1940, pp. 133–135. Remarks pointed out that rigid frame construction has distinct advantages over that of roof truss type in cleanliness, cost of maintenance, lighting, rigidity, cost of foundations, and architectural treatment; some sketches of various types of rigid frames suitable for different kinds of buildings are shown.

GIRDERS, WELDED STEEL. Welded Girders with Inclined Stiffeners, C. D. Jensen, C. M. Antoni and J. B. Reynolds. *Welding J.*, vol. 20, no. 4, Apr. 1941, pp. 170-s–182-s. Girders having vertical stiffeners at panel points and diagonally placed stiffeners, placed in direction of compressive stresses in web, are more efficient than girders having vertical stiffeners only; economy is particularly worth while for long girders over 80 ft in span; fabrication costs compared to old method are neither raised nor lowered. Bibliography. Before Am. Welding Soc.

SURVEYING

BENCH MARKS. Reinforced Concrete Piles for New Orleans Benchmarks, E. N. Bowling. *Eng. News-Rec.*, vol. 126, no. 13, Mar. 27, 1941, p. 493. Establishment of benchmarks at New Orleans, La., on square 25-ft long reinforced concrete piles, surmounted with standard manhole frames and covers.

TUNNELS

CONSTRUCTION. Neuere Anwendung der Unterfangungsbauweise im Tunnel-und Stollenba, K. Wiedemann. *Mitteilungen aus dem Gebiete des Wasserbaues und der Baugrundforschung*, no. 12, 1940, 32 pp. Principles and details of construction of tunnels by so-called Belgian methods; advantages and disadvantages of methods; recent improvements of Belgian methods; field of its application.

CONSTRUCTION, SURVEYING. Continental Divide Tunnel Survey, M. J. Greer. *Reclamation Era*, vol. 31, no. 1, Jan. 1941, pp. 14–17. Discussion of precise surveying methods used to ensure that two opposite headings of 13-mile-long tunnel beneath Continental Divide in Colorado should meet in grade and in alinement.

RAILROAD, LINING. "Umbrella" Cures Severe Wet Condition in Erie Tunnel. *Ry. Eng. & Maintenance*, vol. 37, no. 4, Apr. 1941, pp. 272–275. Expedient employed by Erie Railroad in Otisville tunnel, involving inner lining of shotcrete, to carry leakage to drains at bench walls.

VEHICULAR, SUBAQUEOUS. Die neuen Unterwassertunnel unter dem Mersey-Fluss bei Liverpool und unter der Maas bei Rotterdam, H. Proetel. *VDI Zeit.*, vol. 84, no. 48, Nov. 30, 1940, pp. 932–938. Description and report on construction of Mersey River vehicular tunnel at Liverpool, England, and of subaqueous vehicular tunnel under Meuse River at Rotterdam, Netherlands; lighting and ventilating provisions.

WATER SUPPLY, CONCRETE LINING. Tunnel Concrete Car Design, K. G. Wilkes. *Western Construction News*, vol. 16, no. 3, Mar. 1941, pp. 87–88. Design of special four-compartment 2-yd car used to transport concrete, in limited space, for lining short sections of Mono Craters tunnel on Los Angeles aqueduct; cost of welded car was $41.40.

WATER SUPPLY, CONSTRUCTION. Delaware River Water Supply. *Gen. Contractors Assn.—Bul.*, vol. 32, no. 3, Mar. 1941, pp. 57–60. Progress report on construction of Rondout-West Branch tunnel of Delaware River Water Supply for New York City through Rondout Valley at Wawarsing; exploration by core borings; exploration and advance by drifts; finished tunnel diameter will be 13 ft 6 in. within concrete; combating water inflow by grouting and other means.

WATER PIPE LINES

CEMENT LINED. Cement Lining of Pipe Corrects Bad Water Troubles, R. W. Esty. *Am. City*, vol. 56, no. 4, Apr. 1941, pp. 60–62 and 85. Methods used in cement lining 3,200 ft of cast iron in Danvers, Mass., for purpose of reducing iron and bacteria water; analysis of Danvers waters; description of Tate lining machine.

WATER PUMPING PLANTS

BUFFALO, N.Y. Experiences in Pumping Water, H. W. Fitzgerald. *Water Works Eng.*, vol. 94, no. 5, Feb. 26, 1941, pp. 232–235. History of development and operations of water pumping plants of Division of Water of Buffalo, N.Y., since 1906, now totaling a capacity of 330 mgd; layout of filter plant, boiler room, and pump room of Col. Francis G. Ward pumping station; protection against flooding.

WATER TREATMENT

BRAINTREE, MASS. Complete Treatment of Surface Water Supply. *Am. City*, vol. 56, no. 4, Apr. 1941, pp. 52–53. Description of new 2-mgd water works of Braintree, Mass., featuring rapid-sand filters; wash-water system, and separate industrial supply.

FILTRATION PLANTS, OPERATION. Filter Plant Operating Results at Wheeling, W.Va., N. N. Wolpert. *Water Works Eng.*, vol. 94, no. 5, Feb. 26, 1941, pp. 228–231. Methods of treating Ohio River water; analysis of cost of operation, chemicals used and power consumed; pumping costs.

WATER BACTERIOLOGY. Aguas de bebida y enfermedades infecciosas, C. P. Gandolfo. *Ingenieria* (Buenos Aires), vol. 44, no. 794, Dec. 1940, pp. 1024–1035. Drinking waters and contagious diseases; for medical men, drinking water problem reduces itself, in general, to securing fresh, clean, odorless, palatable water, not subject to putrefaction and suitable for principal domestic uses; detailed discussion of types of bacteria found in water, and their pathological effects; purifying effect of solar rays, particularly ultra-violet rays.

WATER WORKS ENGINEERING

NATIONAL DEFENSE, WATER SUPPLY. Large Reserve of Repair Parts to Aid National Defense. *Water Works Eng.*, vol. 94, no. 5, Feb. 26, 1941, pp. 246, 249–250, and 252. Summary of opinion of water works superintendents for or against nearby communities pooling their resources of repair and replacement parts and units for promotion of national defense.

ONTARIO. Problems Involved in West Lorne Water Supply, M. T. Gray. *Water & Sewage*, vol. 79, no. 2, Feb. 1941, pp. 11–15 and 34. Design and construction of water works of village of West Lorne, Elgin County, Ontario (population 1,000), deriving its supply from Lake Erie; location of filtration plant; description of intake and pumphouse; details of treatment plant; pumping and distribution; cost of water works, including distribution system, is about $130,000.

OPERATION. Reducing Unaccounted for Water, C. O. Thomas. *Pub. Works*, vol. 72, no. 2, Feb. 1941, pp. 21–22, 24, and 35. Report on measures taken at Hope, Ark. (population 7,500), for reducing unusually large amount of unaccounted for water from 40% to 21% of total consumption.

Literature Available

Bituminous Mixer—"Versatility" is the title of a booklet issued by the Barber-Greene Co., Aurora, Ill. It shows the three basic set-ups of: Travel Plant for Low Cost Road Mix; Central Plants for "Intermediate" Type Mixes and with Gradation Control for High Type Mixes. The correct applications, advantages, and limitations of each are thoroughly discussed. Request Bulletin No. 8-42.

Bulldozers and Graders—Bucyrus-Erie's new line of hydraulic bullgraders and bulldozers for International Trac-Tractors is described in their 24-page Bulletin No. BGD-6. Photographs, drawings, diagrams and specifications cover construction details, design features, and performance on the Job. Publicity Department, Bucyrus-Erie Co., South Milwaukee, Wis.

Concrete Mixers—The complete line of Rex Concrete Mixers from the 3½-S up to and including the 14-S are described and illustrated with complete information on their individual features in the new 1941 catalog of Chain Belt Co., Milwaukee, Wis.

Concrete Waterproofing—A discussion of integral waterproofing covers the three general types—stearates, calcium chloride, and plasticizers—and their characteristics. Bulletin No. 3-B-1. Medusa Portland Cement Co., 1099 Midland Bldg., Cleveland, Ohio.

Diesel Electric Sets—The versatility of the modern packaged Diesel power plant is clearly shown in a booklet about Diesel-Electric Sets. In addition to a detailed description of the Diesel engine and the self-regulating generator, "Caterpillar" has listed, discussed, and photographed more than a score of different kinds of installations. Dimensions and specifications of the company's eight sizes of electric sets are given. Write to Caterpillar Tractor Co., Peoria, Ill.; request Form 6344.

Electrical Equipment—A 64-page 1941 revision of the popular "Quick Selector" Catalog No. 30-000, which simplifies the selection of electrical equipment for any motor, lighting or feeder circuit, is announced by Westinghouse Electric and Manufacturing Co., Dept. 7-N-20, East Pittsburgh, Penna.

Pumps—Allis-Chalmers Mfg. Co., Milwaukee, Wis., has issued a new comprehensive 40-page Bulletin B-1646, for every pumping service requiring a high-grade single-stage double-suction centrifugal pump. Construction features, pump dimensions, normal and special application data, friction tables, head-capacity tables, and other data are presented.

Swim Pool Sanitation—An 8-page folder on the safeguarding of health in public pools covers Chloramine disinfection, Coagulation and pH control and the fundamentals of disinfecting foot baths, showers, locker rooms and walkways. Proportioneers, Inc., 14 Codding St., Providence, R.I.

Equipment, Materials, and Methods

New Developments of Interest, as Reported by Manufacturers

Fabricated Building Partition

BUILDING PARTITIONS in which all materials, with the exception of plastering supplies, are designed, fabricated and shipped knocked-down as a complete unit, is the latest development of the Reynolds Metals Co., Richmond, Va.

The new product, named Reyn-O-Wall, is a lightweight partition system, two inches thick, for use in the construction of non-load bearing walls, and is made of two layers of steel-reinforcement securely attached to each other, leaving an air space between the layers. This hollow core is reinforced on both sides with vertical galvanized steel V-shaped ribs. Simplified erection is claimed as an outstanding advantage of this new type partition wall. The prefabricated core sheets are self-supporting, requiring no studs, and are erected in units extending in one piece from floor to ceiling. U-shaped anchor clips of galvanized wire are supplied for firmly securing adjacent core sheets together. Reyn-O-Wall is lighter in weight than ordinary partitions, is fire-resistant, and the hollow core provides high sound-deadening value. It is also said to provide substantial savings in plaster materials.

New Sound-Level Meter

A NEW PORTABLE sound-level meter, lighter and more compact than any previous instrument of this kind, has been built by the General Electric Co., Schenectady, N.Y. It weighs only 19 lb but has a range of 24 to 120 decibels or, roughly, from the rustle of leaves to the scream of a factory whistle. The new meter may be used quickly and conveniently for almost any kind of noise study, including traffic noise; sound in auditoriums; and noises of motors, fans, generators, turbines, bearings, gears, and other parts of machinery.

Essential parts of the device are a microphone, an amplifier and an indicating instrument. An arm extension protects the microphone from sound reflected from the case. The amplifier consists of five stages which are resistance coupled. The battery-operated tubes are mounted on a shock-proof base, thus reducing errors due to vibration. A switch permits the selection of one or three ear-weighting networks, 40 decibels, 70 decibels or flat frequency response giving the instrument a response similar to that of the human ear. In field use the instrument is calibrated by applying a precision mouth-blown calibrating unit to the microphone.

It is designed to perform in accordance with the recently adopted American Standards Association standards for sound level meters. The complete instrument, including the microphone and mounting arm, calibrating unit and batteries, is contained in a carrying case 12¾ in. long, 7¾ in. wide and 9¼ in. high.

Richmond's Calendar Is Builders Almanac

RICHMOND SCREW ANCHOR COMPANY has for distribution a large size wall calendar which is in reality an "Almanac" for engineers and contractors doing concrete form work. Arranged on the large sheet calendar are charts and tables of:

1. Practical concrete pouring suggestions
2. Common form lumber data
3. Wire nail facts; sizes, length, strength
4. Decimals of a foot for each ¼ in. up to 12 in.
5. Weights and areas of reinforcing steel
6. Water-cement ratios
7. Richmond Ty-Spacing chart giving complete information on Ty-Spacing, form lumber, concrete rise per hour, etc.

This Ty-Spacing chart also appears on the package labels used on all deliveries of Richmond's form-tying devices. These labels give in blueprint style the complete data for the most effective handling of the job; vertical and horizontal Ty-Spacing; square feet per Ty; rise of concrete per hour in forms at various temperatures; and simple and specific instructions for setting up and stripping forms with the particular Ty which the package contains.

This assures the placing of correct tying instructions on the job with every Richmond shipment. Another assurance on the label is the prominently displayed statement that Richmond Screw Anchor Co. are the sole owners and patentees for Richmond Products.

For copies of the calendar "Almanac" write to Richmond Screw Anchor Co., 816 Liberty Ave., Brooklyn, N.Y.

Portable Light Plant

THE KATO ENGINEERING Co. of Mankato, Minn., announces a new four-cylinder Katolight Plant, 44A, which generates 4,000 watts at 1,800 rpm or 2,000 watts at 1,200 rpm standard 110-volt, 60-cycle ac. It is powered with a four-cylinder 14 hp LeRoi air-cooled engine. The unit is 42 in. long, 20 in. wide, and 29 in. high; net weight approximately 800 lbs. The 44A6, 1,200 rpm unit weighs about 875 lbs.

This is reported to be an ideal plant for stand-by service or continuous duty application. Engine is furnished with magneto and emergency hand crank. Two six-volt batteries furnish self-cranking current.

Other sizes in 1,800 rpm models range from 240 to 10,000 watts; 1,200 rpm models available in sizes 1,500 to 7,500 watts. Remote control available for all models, and full automatic available on ac models up to 5,000 watts.

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